Soil!
What it is and how it works.

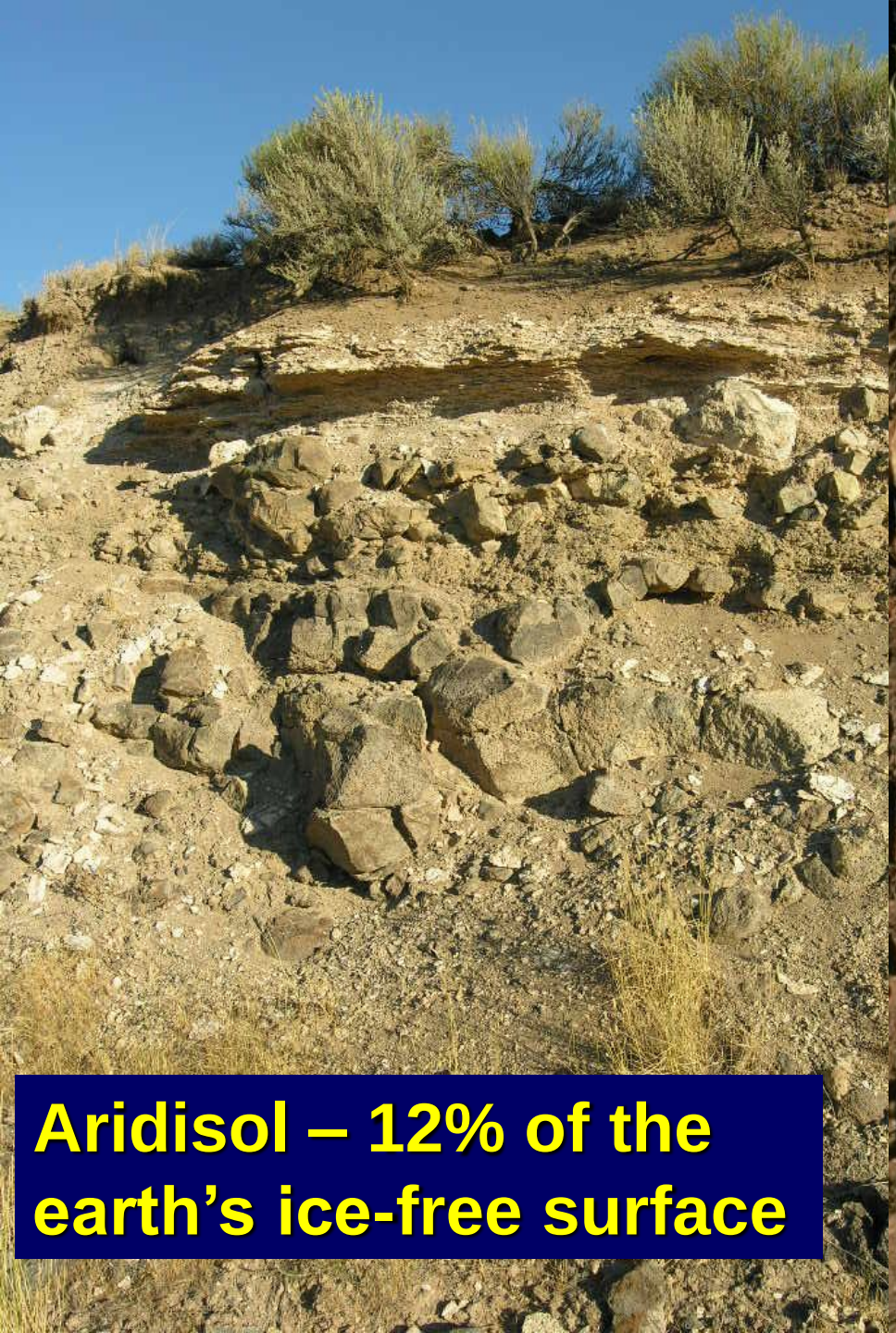
James Cassidy – Oregon State University, Soil Science
Faculty Advisor and Founder OSU Organic Growers Club
President Oregon Society of Soil Scientists
Soilforward.org

Soil!

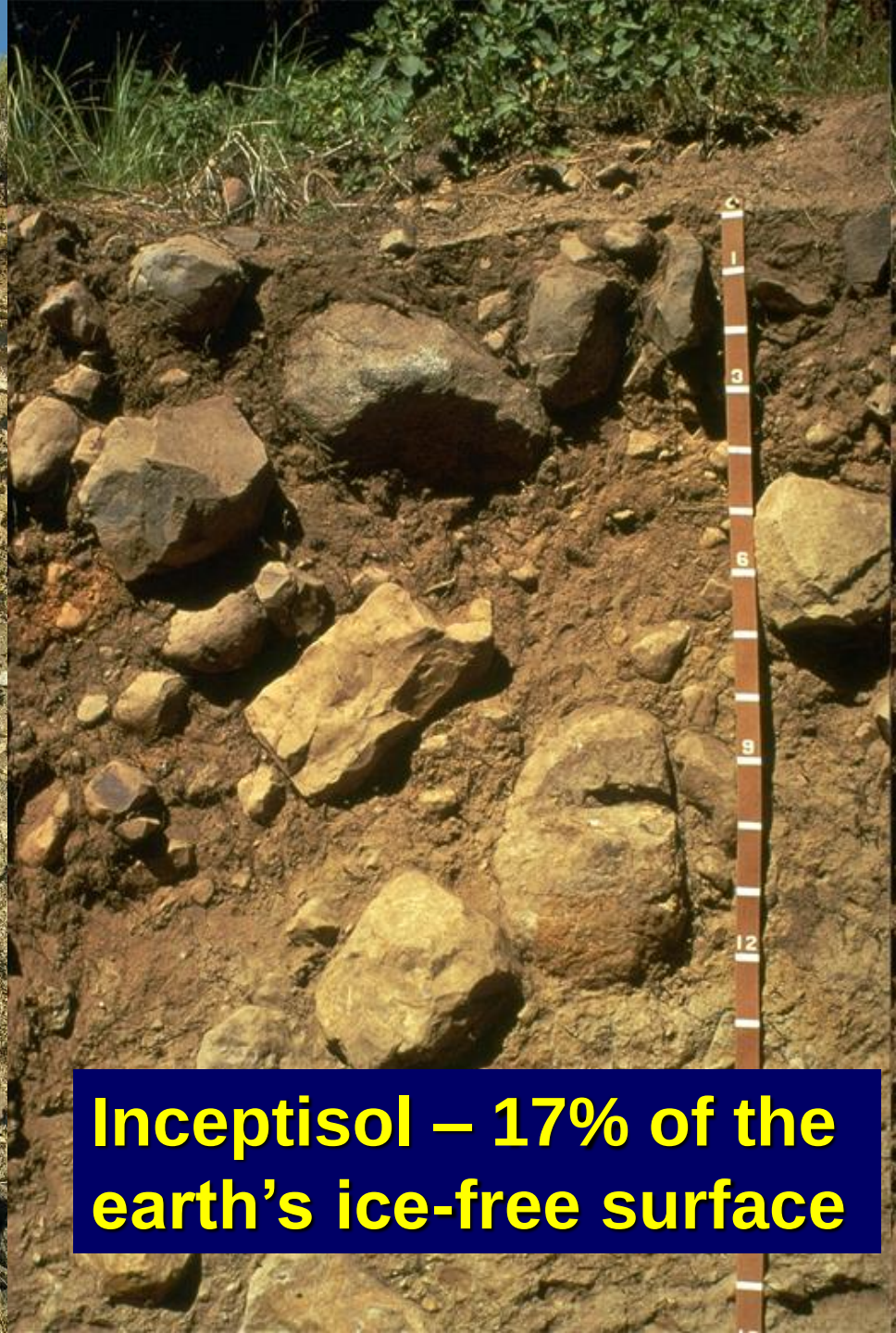
2 of the 12 Soil Orders

Aridisol

Mollisol

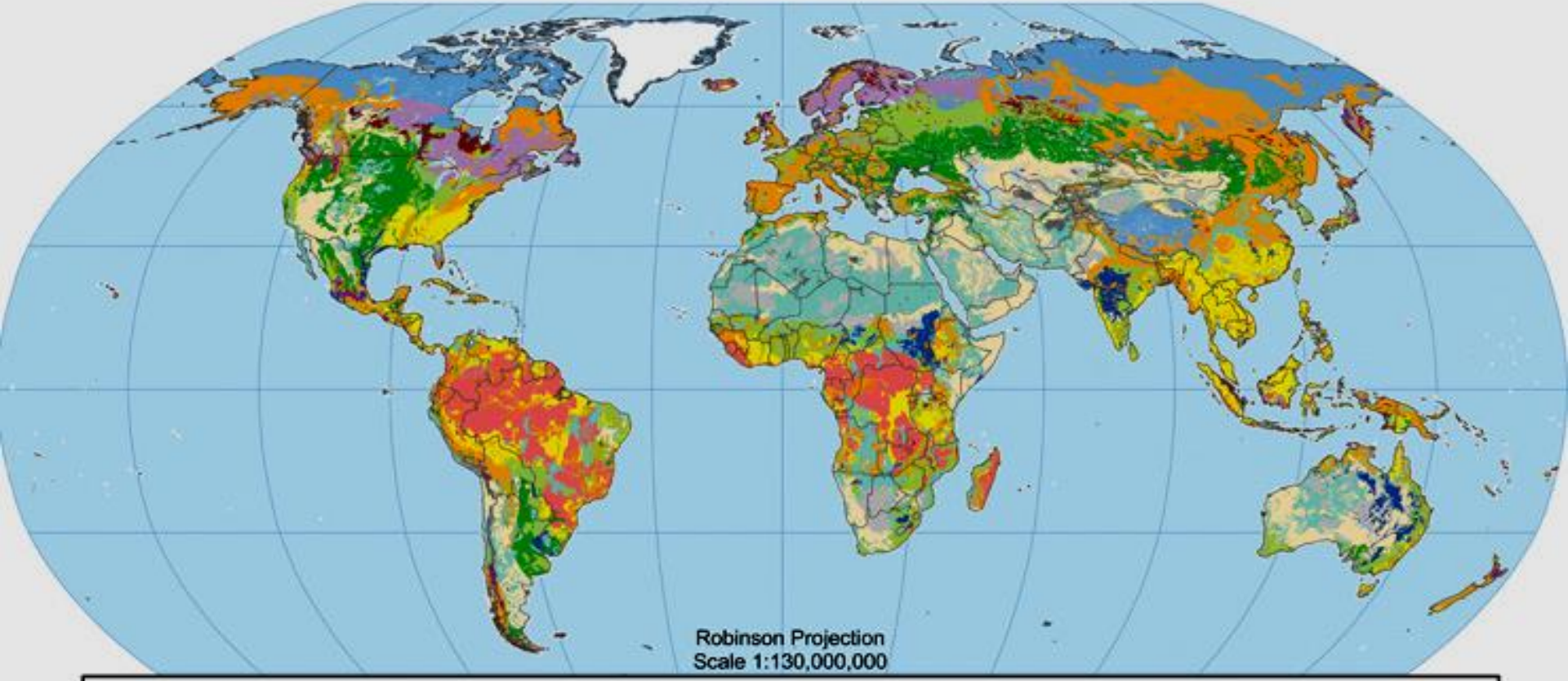


Aridisol – 12% of the earth's ice-free surface



Inceptisol – 17% of the earth's ice-free surface

Global Soil Regions



Soil Orders

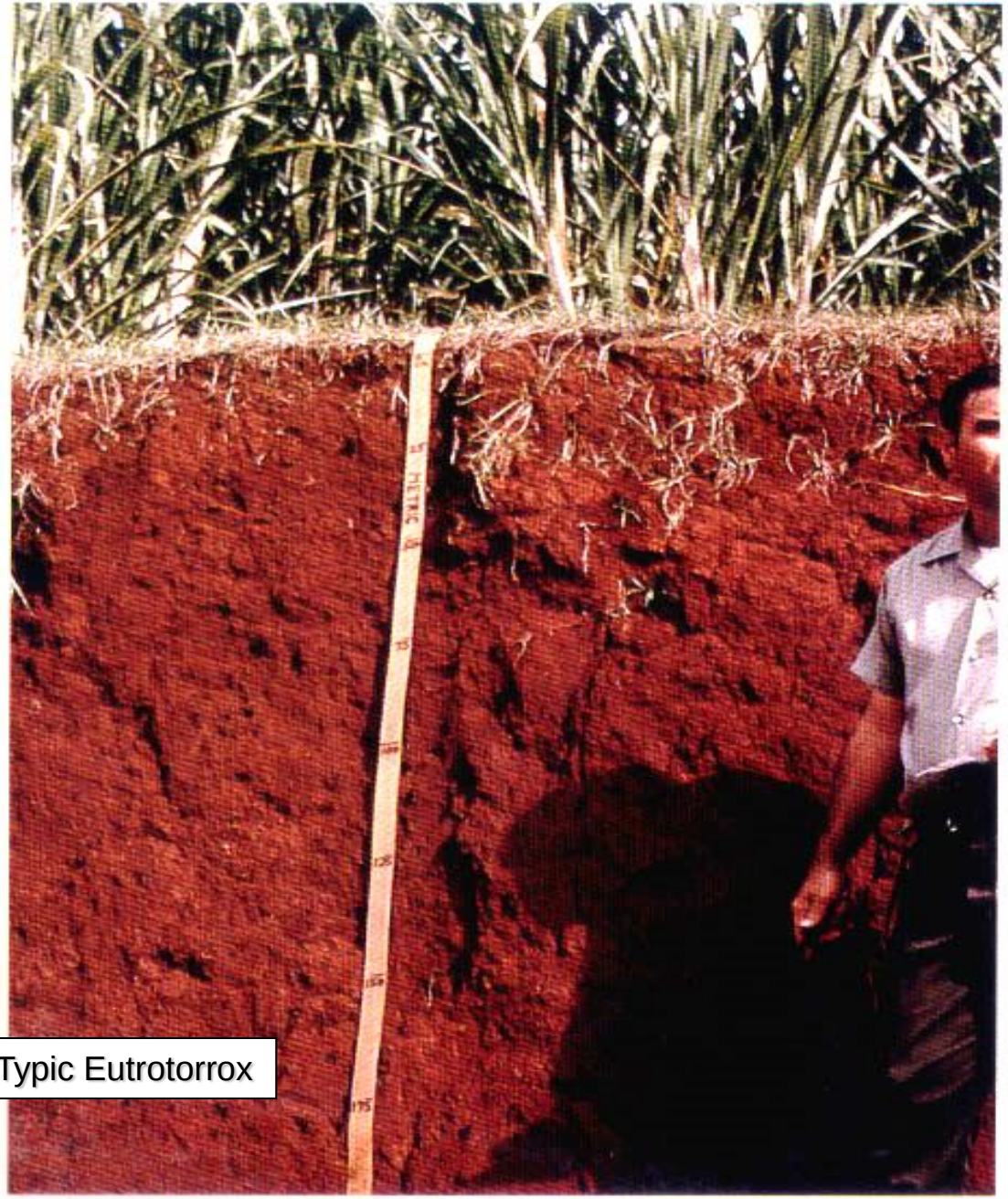
Alfisols	Entisols	Inceptisols	Spodosols	Rocky Land
Andisols	Gelisols	Mollisols	Ultisols	Shifting Sand
Aridisols	Histosols	Oxisols	Vertisols	Ice/Glacier

USDA NRCS US Department of Agriculture
Natural Resources
Conservation Service

Soil Survey Division
World Soil Resources
soils.usda.gov/use/worldsoils

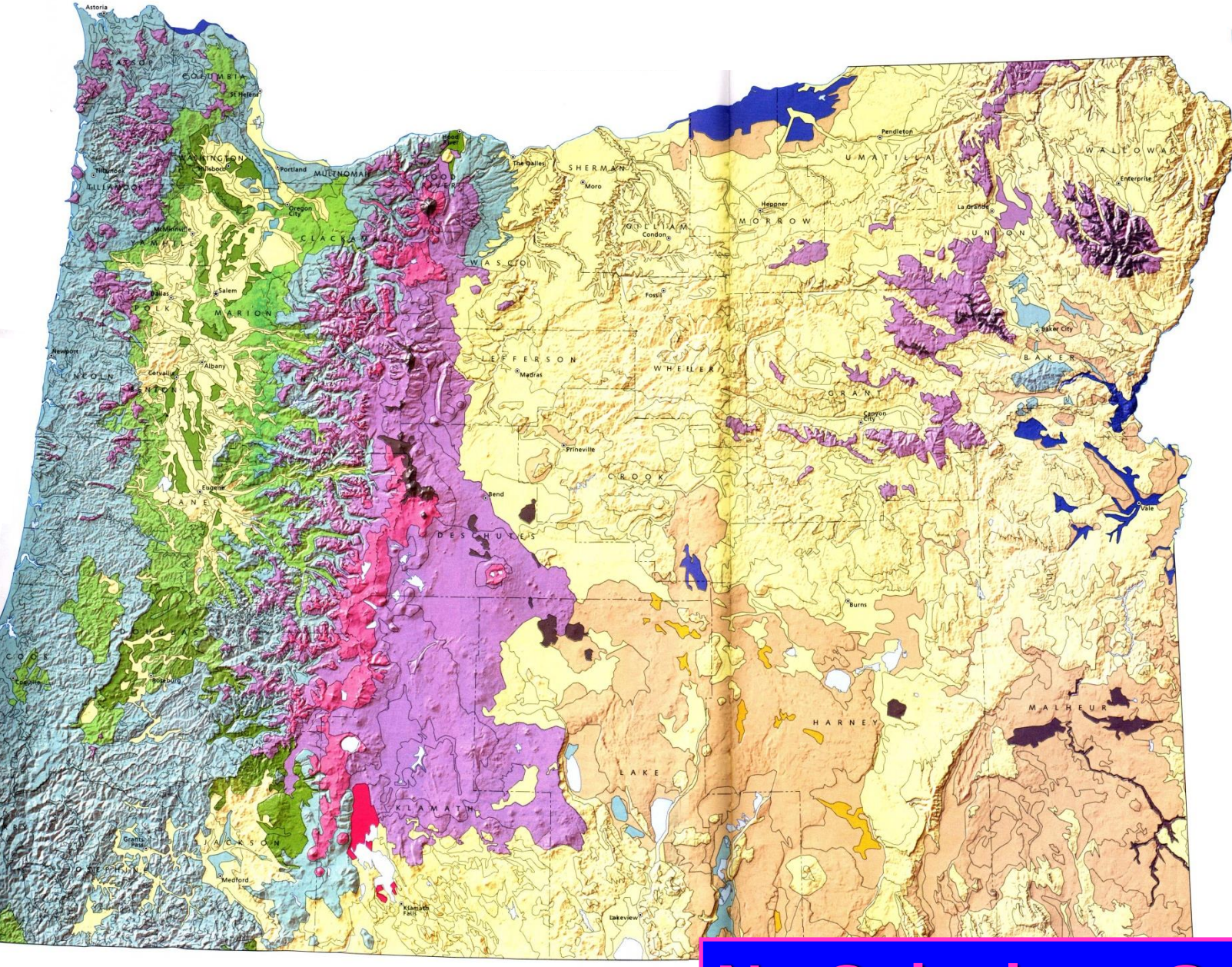
November 2005

Oxisols



Very-fine, kaolinitic, isohyperthermic Typic Eutrotorrox

Plate 34 Molokai Oxisol growing sugarcane on Oahu, Hawaii. (A. R. Southard)



Soil Descriptions

Inceptisols
ils that are beginning to form and have weakly developed il profiles. Inceptisols are most common in the Coast Range, here they have dark surface horizons (or layers, as when ewed in cross-section) enriched with organic matter and bsoils in which only brighter colors and better structures fferentiate the soil from the parent material. Inceptisols in e Klamath Mountains are similar, but have thinner surface rizons that are lower in organic matter.

Ultisols
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Rock **Water**

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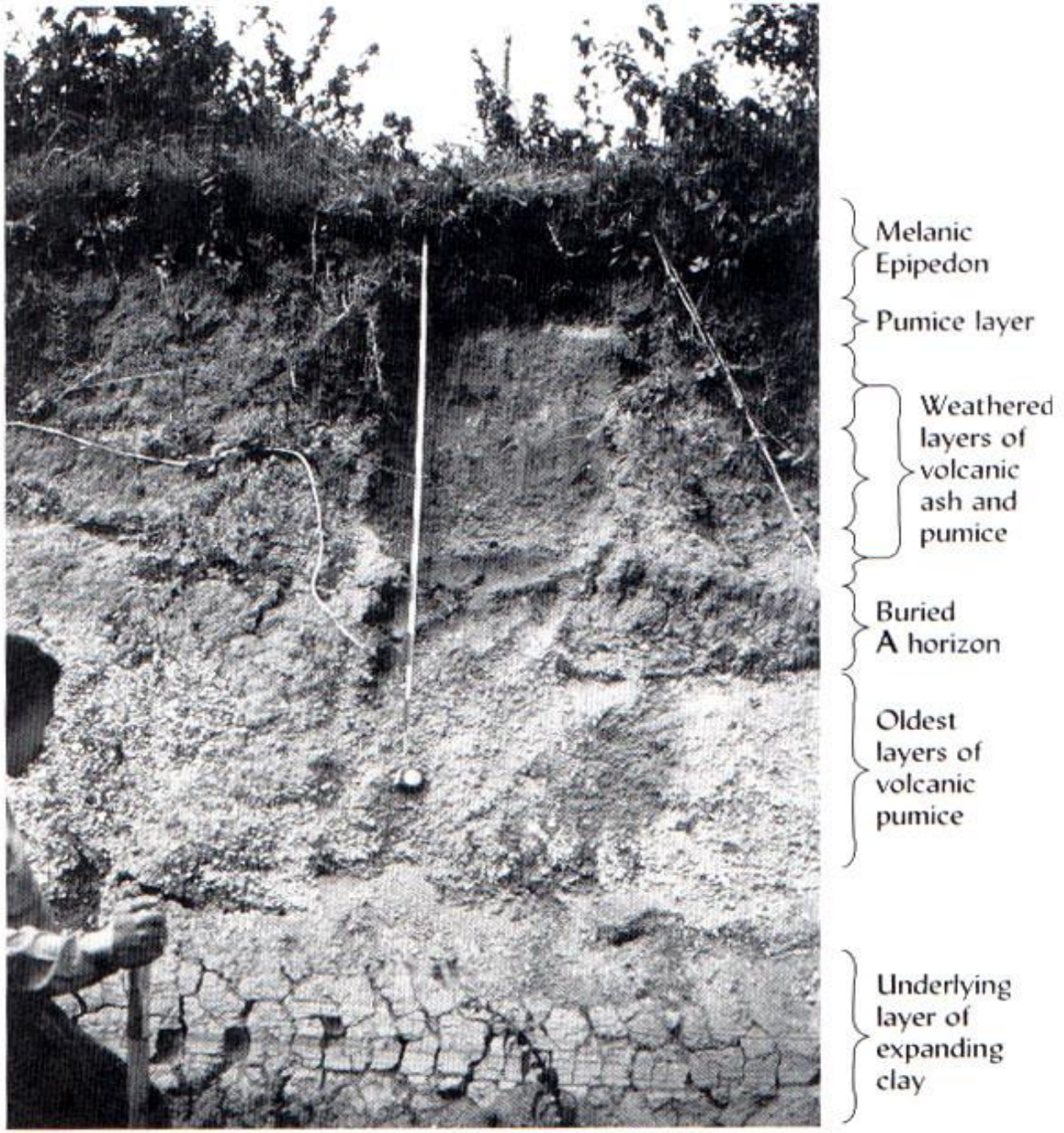
No Oxisols or Gelisols!


Spodosol
Oregon Coast

Andisols

Central Africa



Entisols

PLATE 4 Entisols—a Typic Quartzipsamment from eastern Texas. Scale in feet.

Inceptisols

A 0 –5 cm

AB 5- 18

Bw1 18 - 33

Bw2 33 - 55

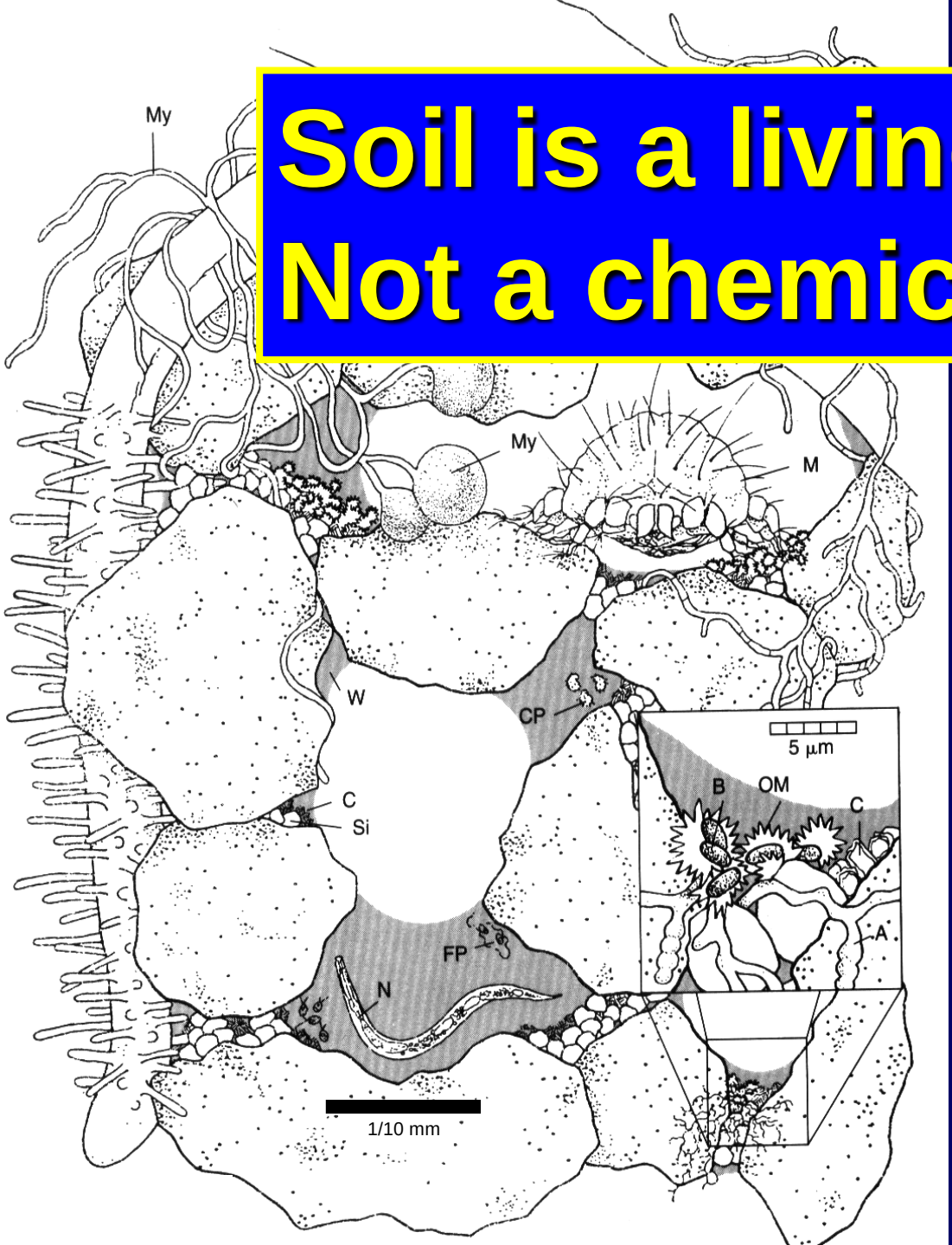
BC 55 - 76

C 76 – 100+

GEORGIA COARSE-LOAMY, MIXED, SEMIACTIVE, MESIC AQUIC DYSTRIC EUTRUDEPTS


Soil is habitat!

Soil is a living thing!
Not a chemical sponge!



B – Bacteria
A – Actinomycetes
My – Mycorrhizae
H – Saprophitic fungus
N – Nematode
CP – Ciliate protozoa
FP – Flagellate protozoa
M – Mite

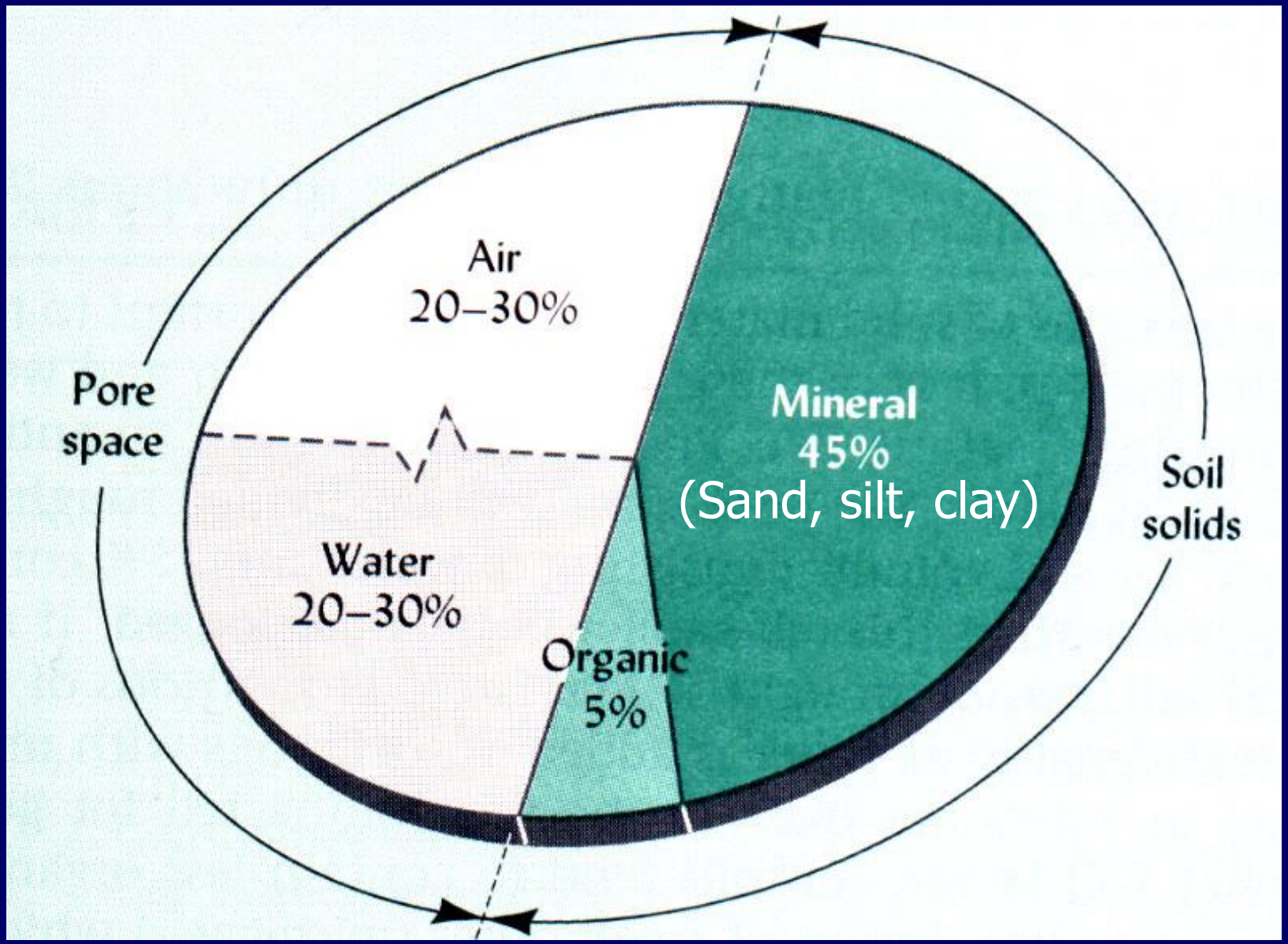
< 1mm

What is Soil?

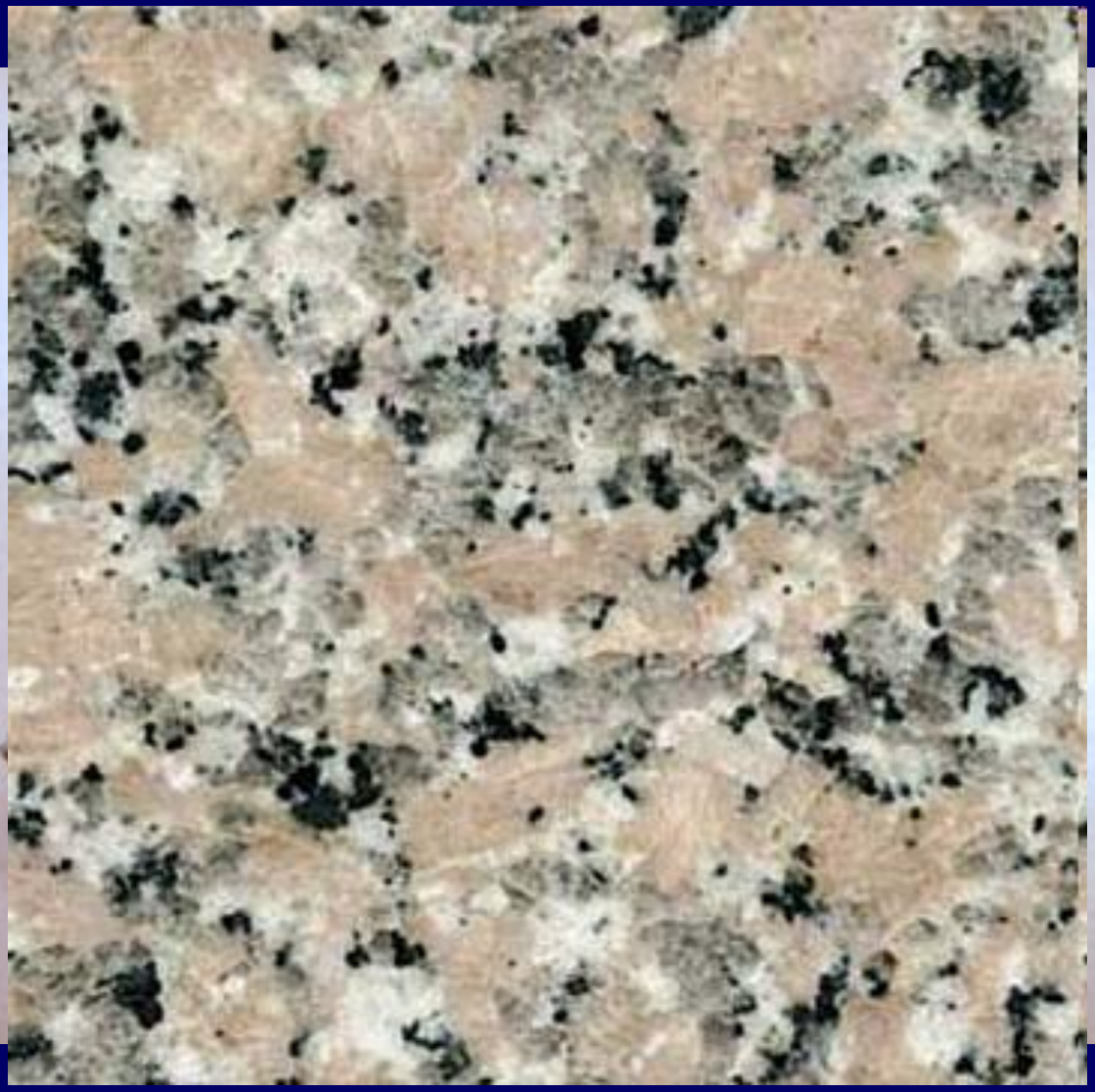
Soil is:

- "Rotted" Rock
- Decomposed Organic Matter

The four components of soil:



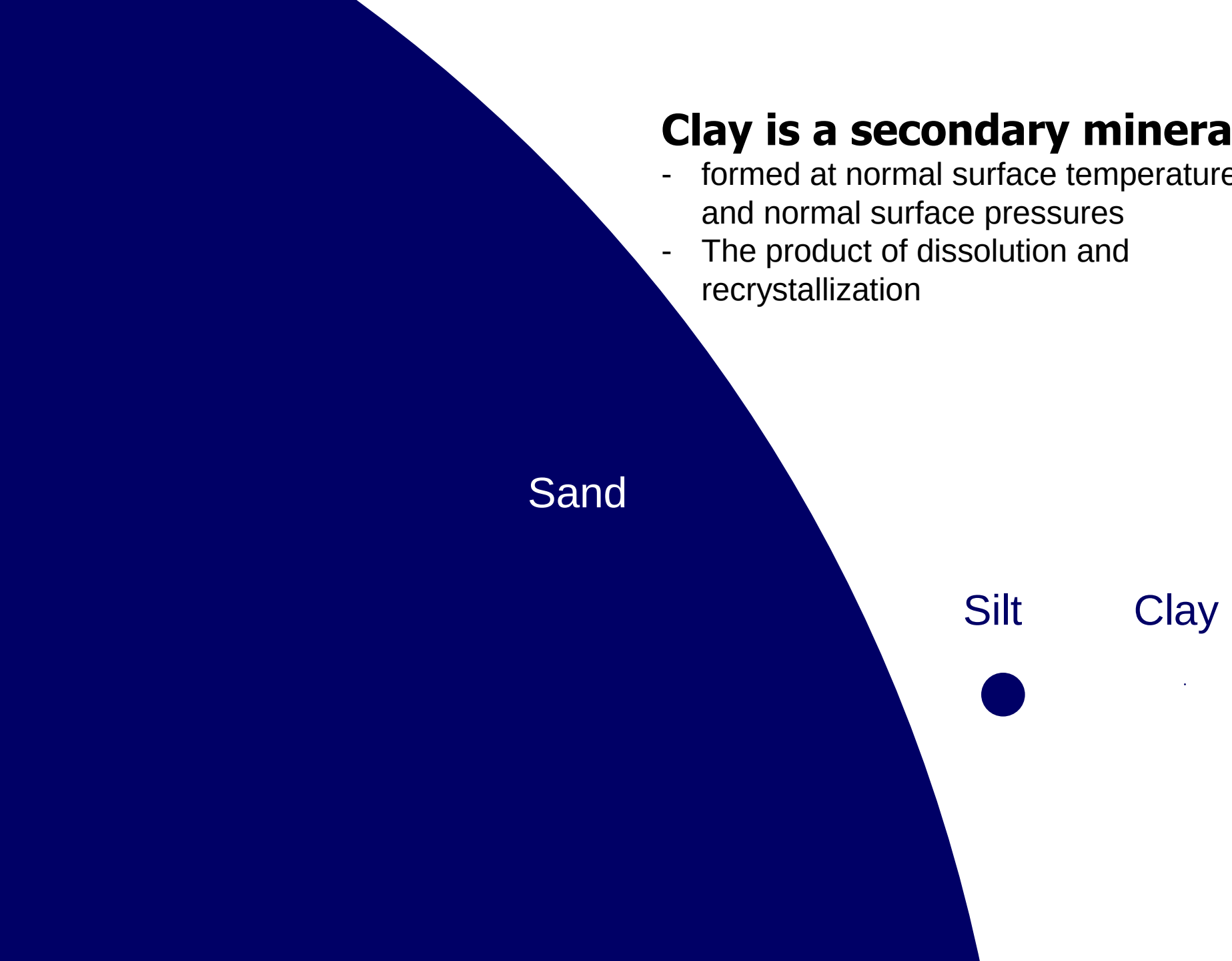
Rock – primary mineral



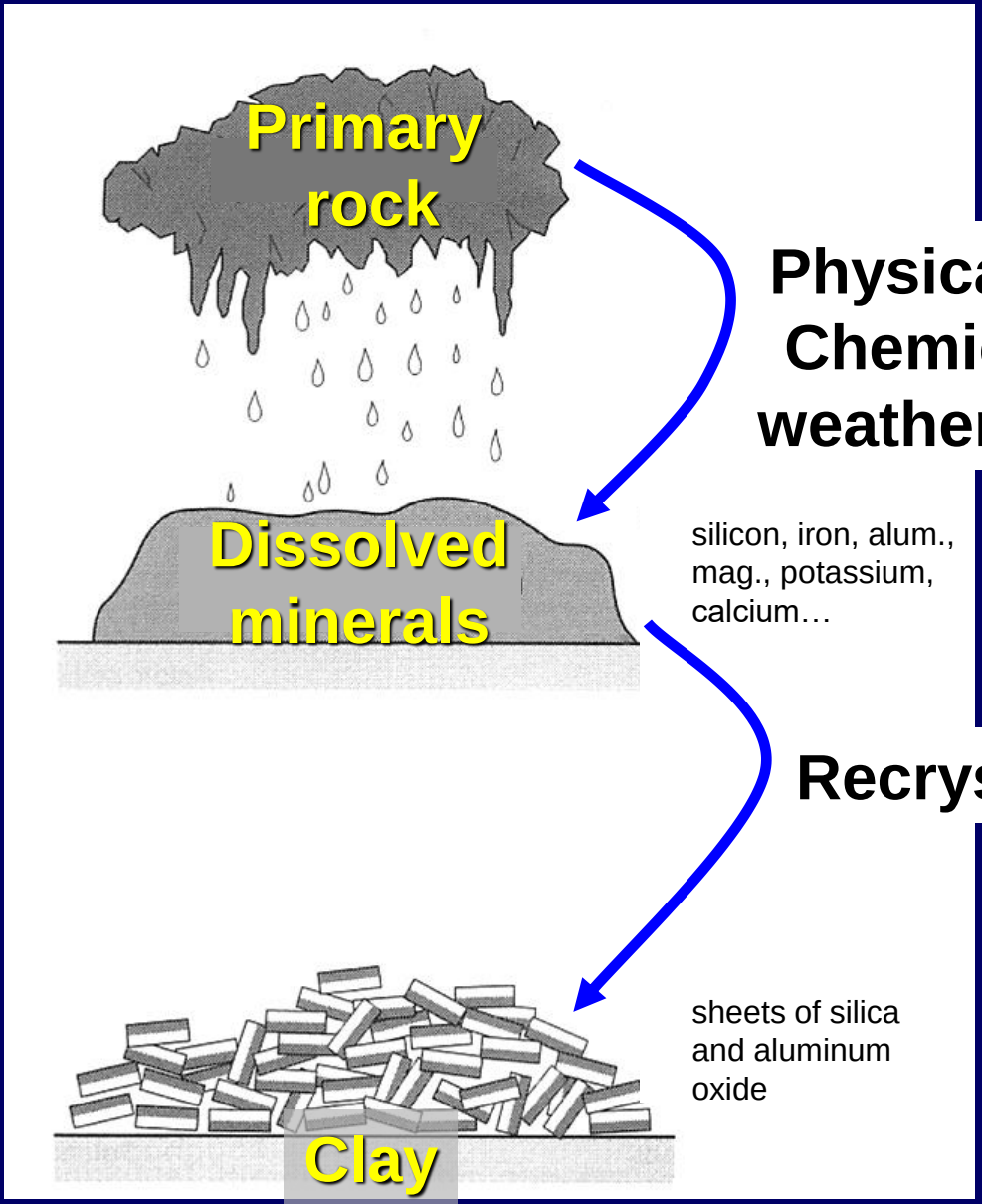
Granite

Clay is a secondary mineral

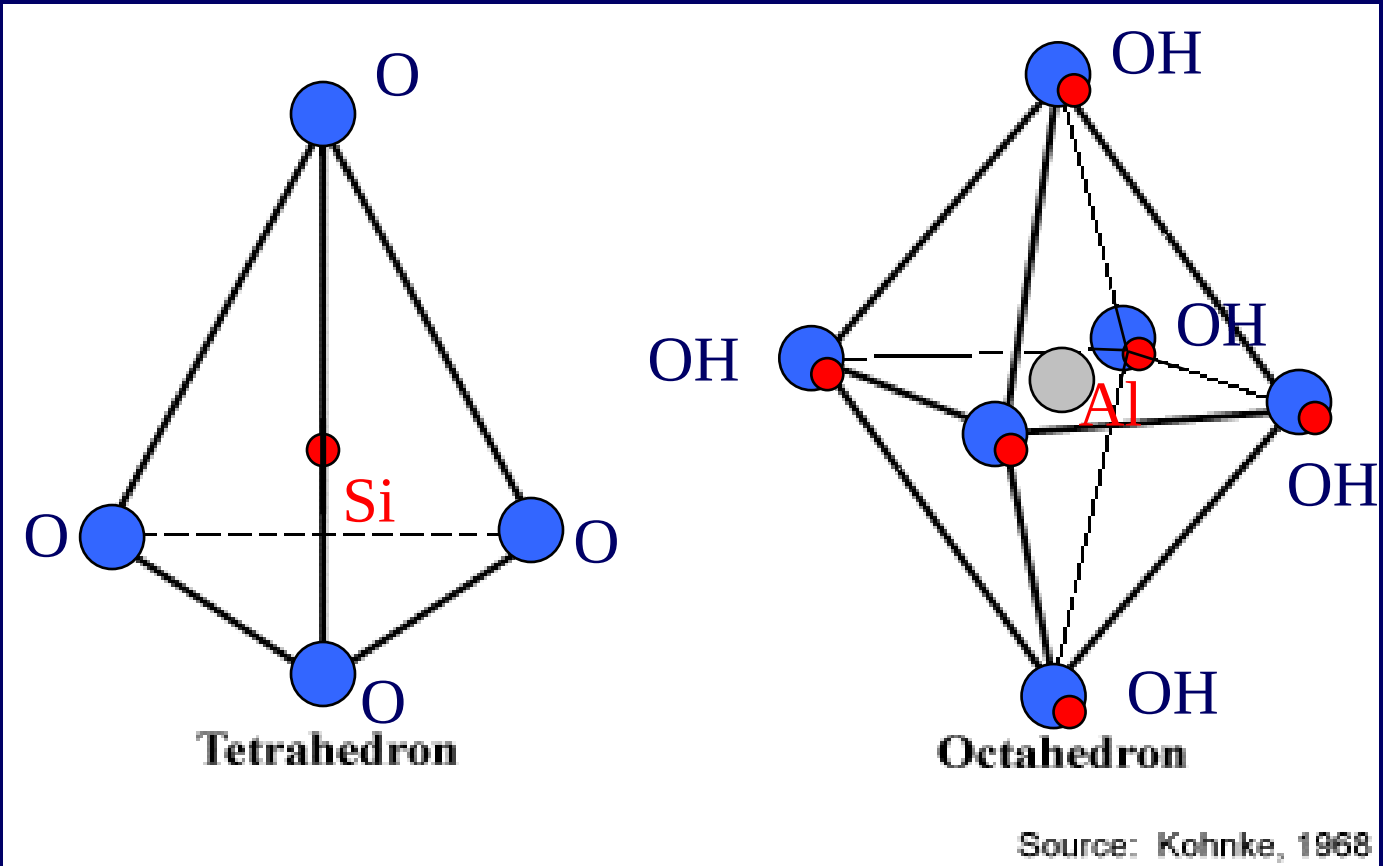
- formed at normal surface temperatures and normal surface pressures
- The product of dissolution and recrystallization



Rocks dissolve and recrystallize



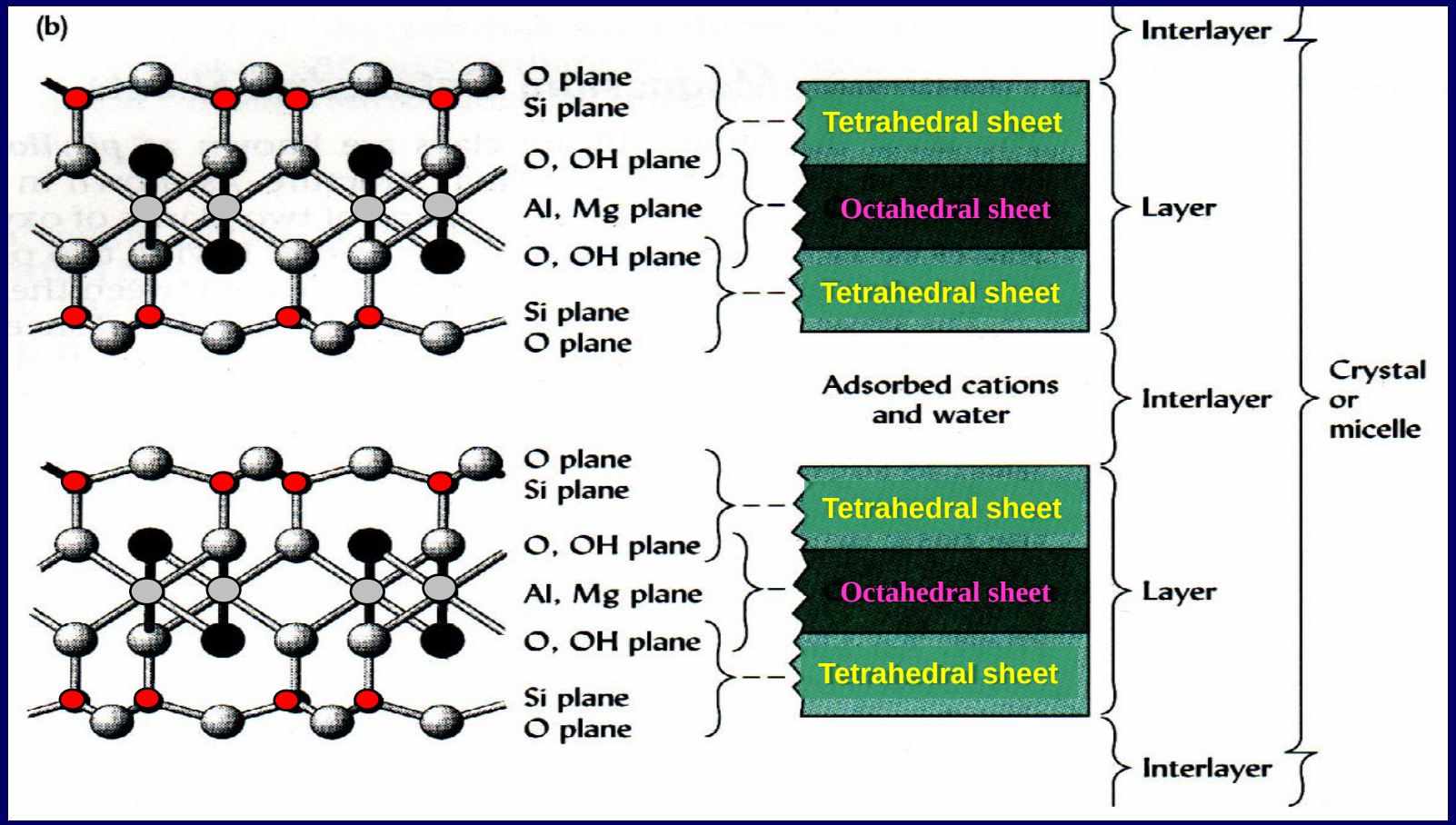
When rocks dissolve…

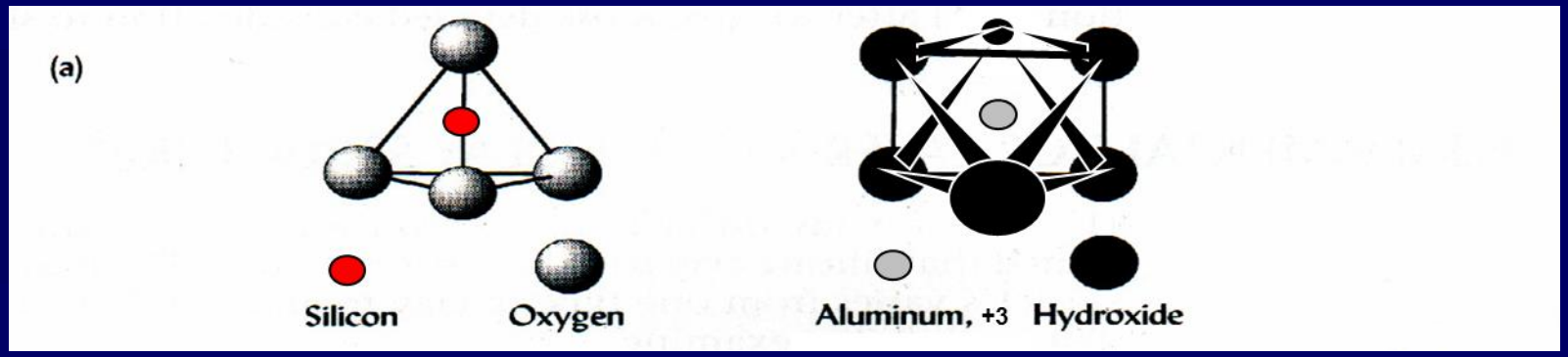


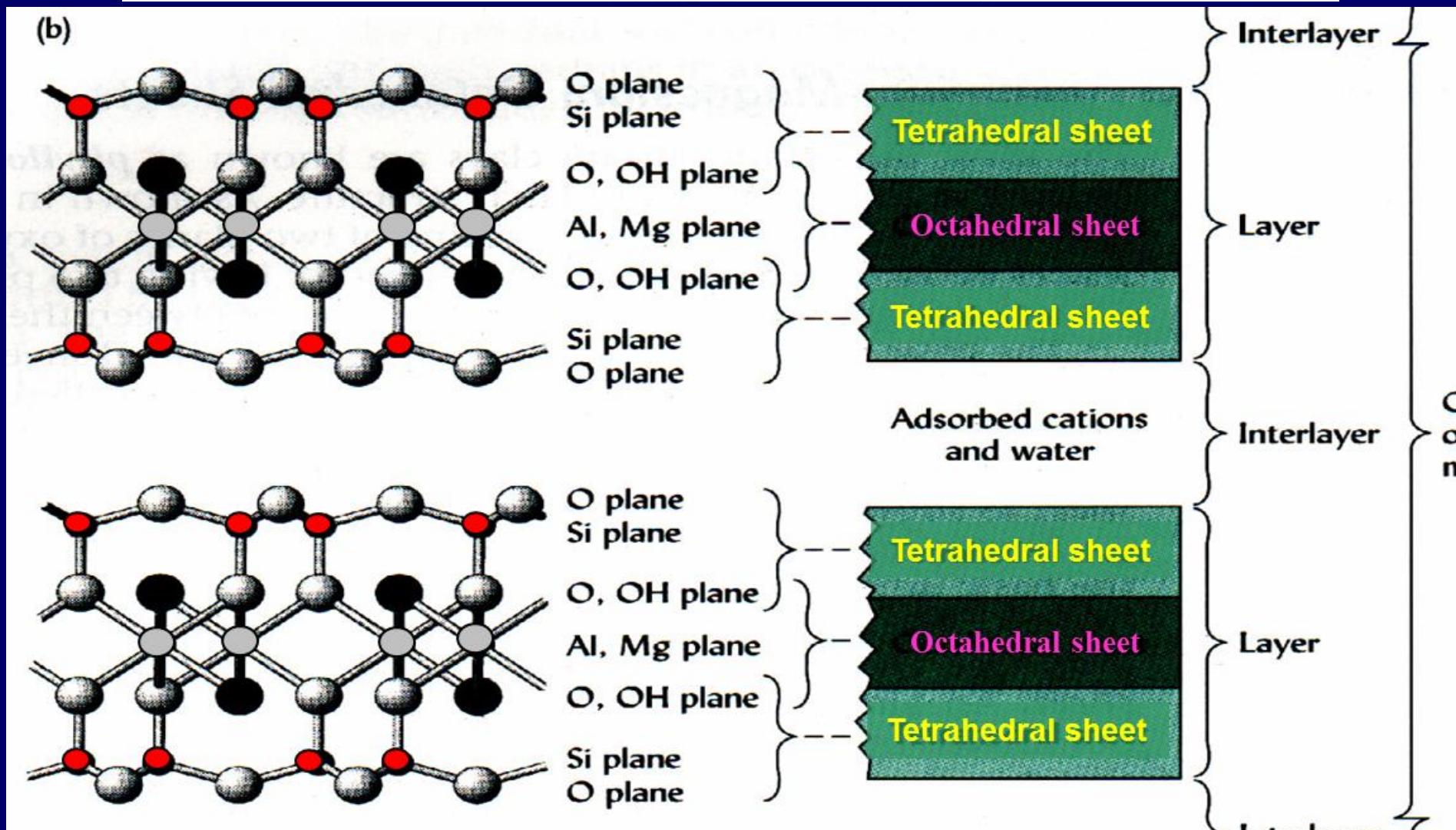
Tetrahedron - a 3D geometric form contained by four plane faces; a triangular pyramid.

Octahedron - a 3D geometric form contained by eight plane faces.

…and recrystallize. Clay – secondary mineral

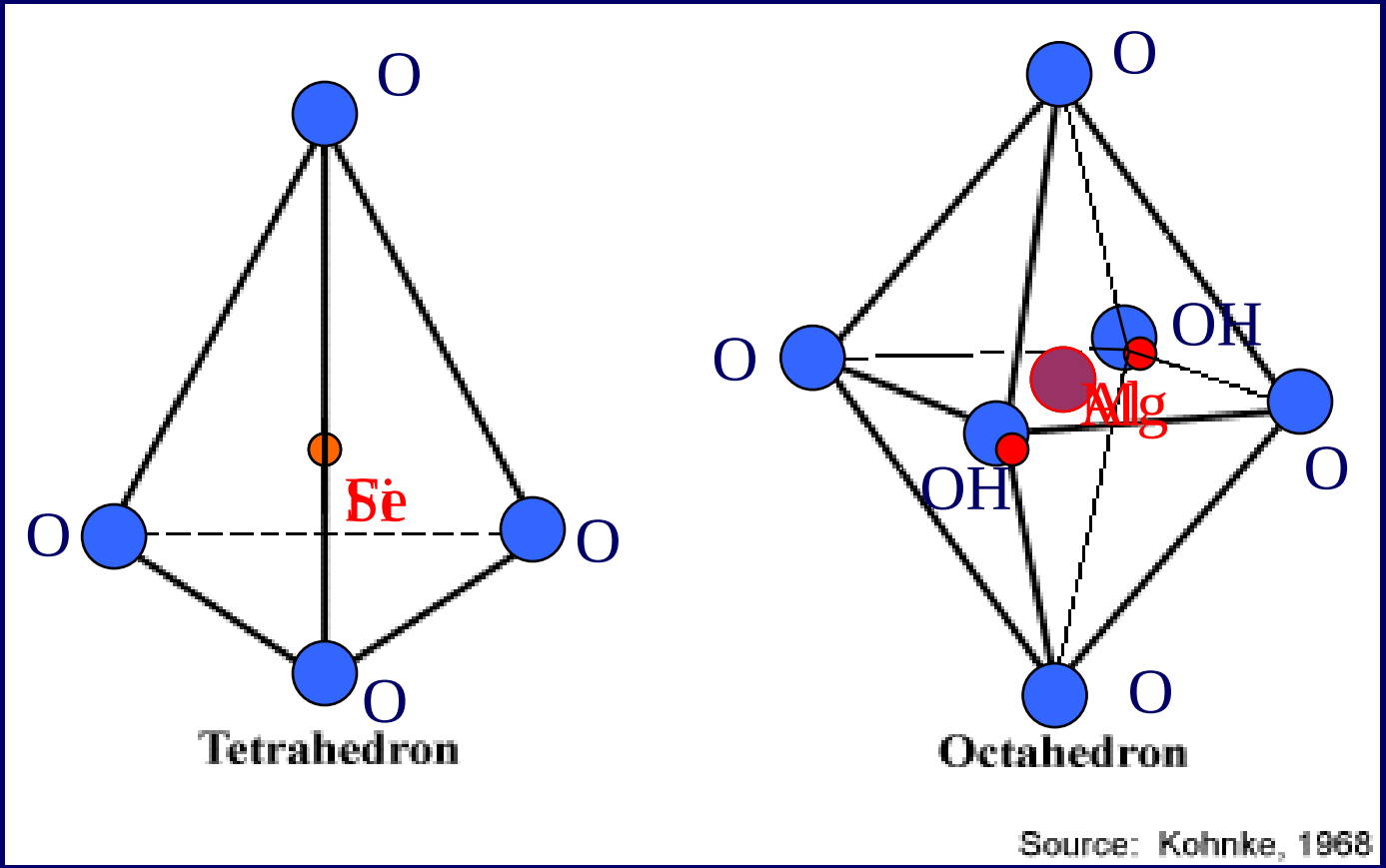



(a)
Silicon
Oxygen
Aluminum, +3
Hydroxide


(b)
O plane
Si plane
O, OH plane
Al, Mg plane
O, OH plane
Si plane
O plane
Tetrahedral sheet
Octahedral sheet
Tetrahedral sheet
Interlayer
Layer
Adsorbed cations and water
Interlayer
O plane
Si plane
O, OH plane
Al, Mg plane
O, OH plane
Si plane
O plane
Tetrahedral sheet
Octahedral sheet
Tetrahedral sheet
Layer

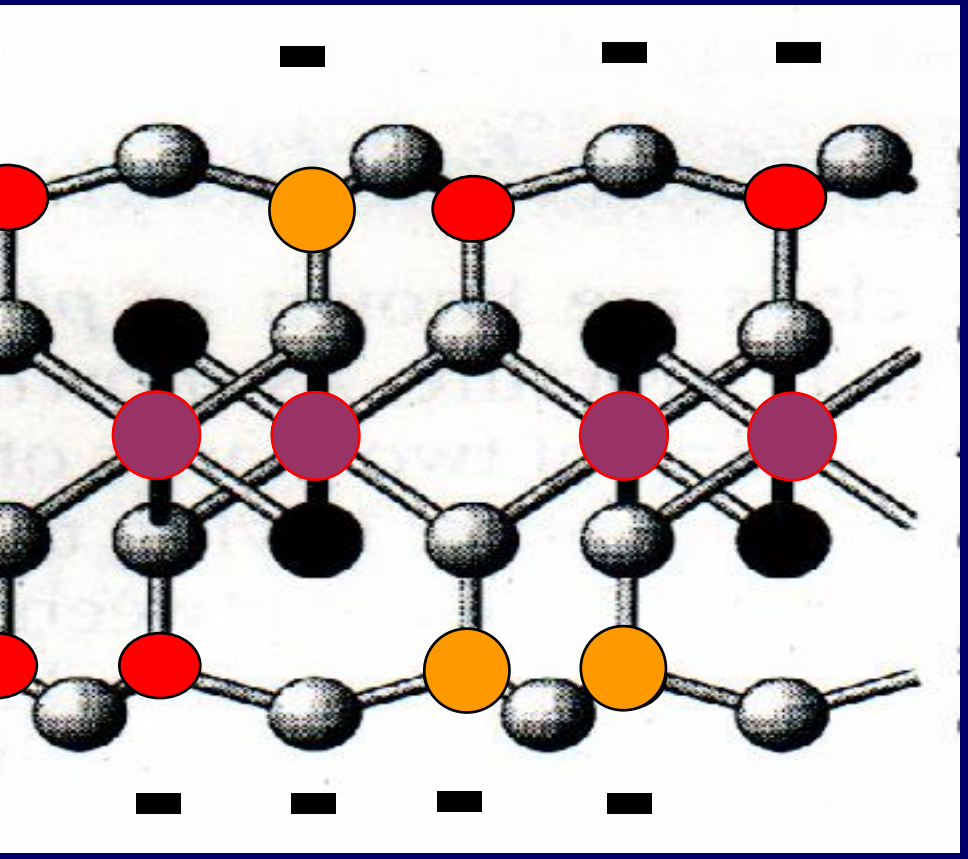
Isomorphous substitution

Within the silica tetrahedron and aluminum octahedron



What ions are present in the soil water solution is determined by the PM and the weathering environment.

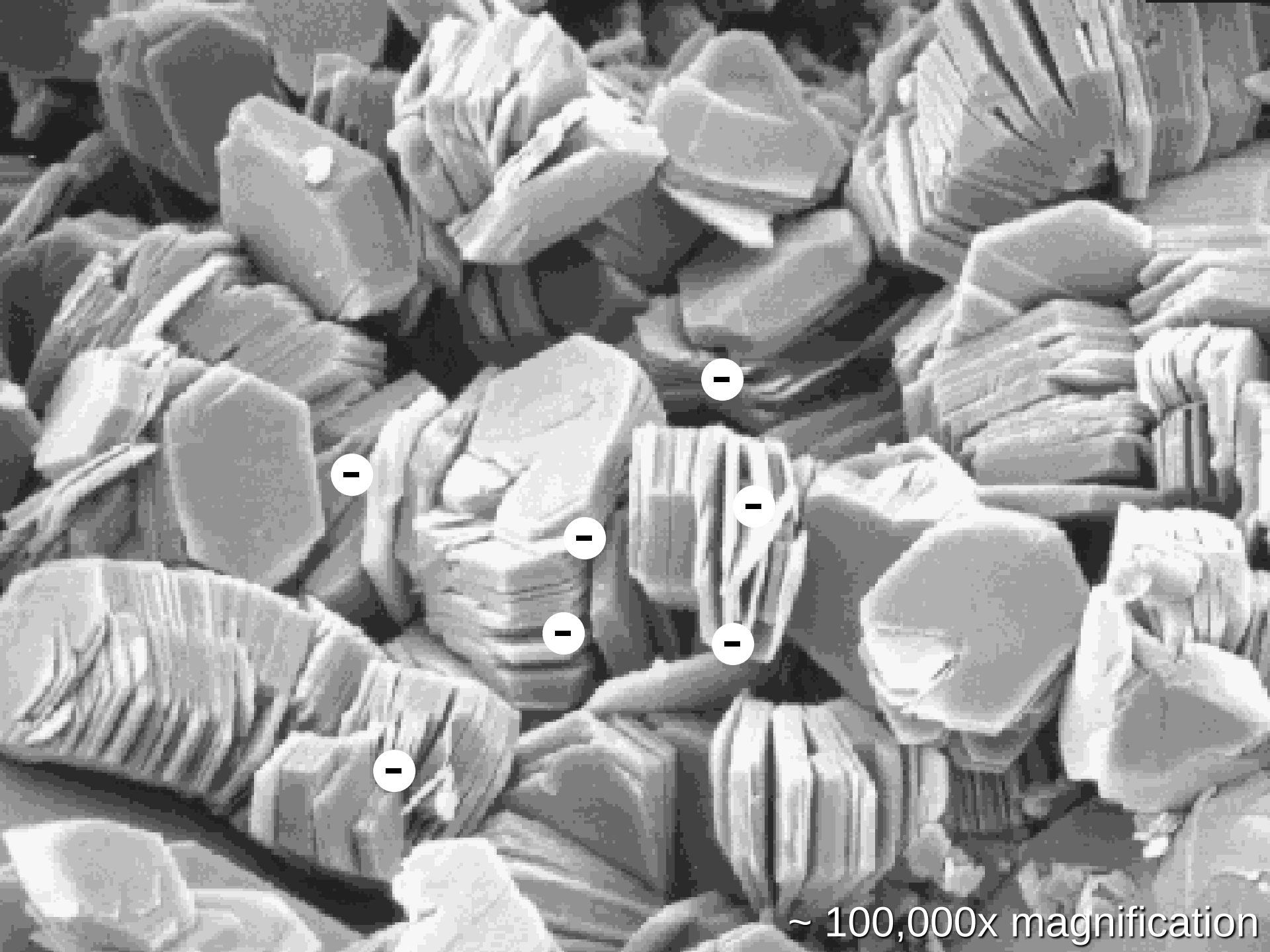
Isomorphic Substitution… a source of negative charge in soils!

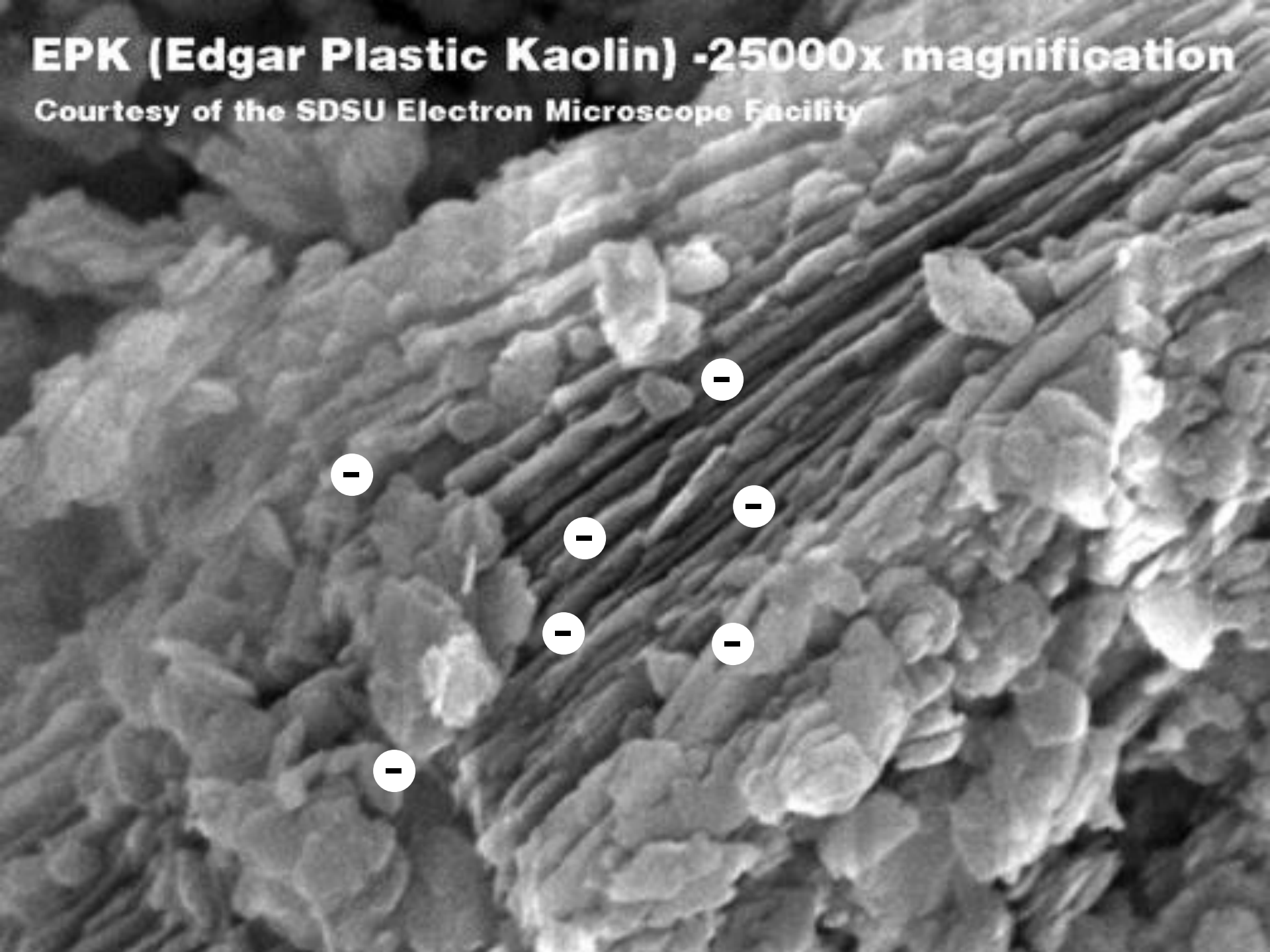


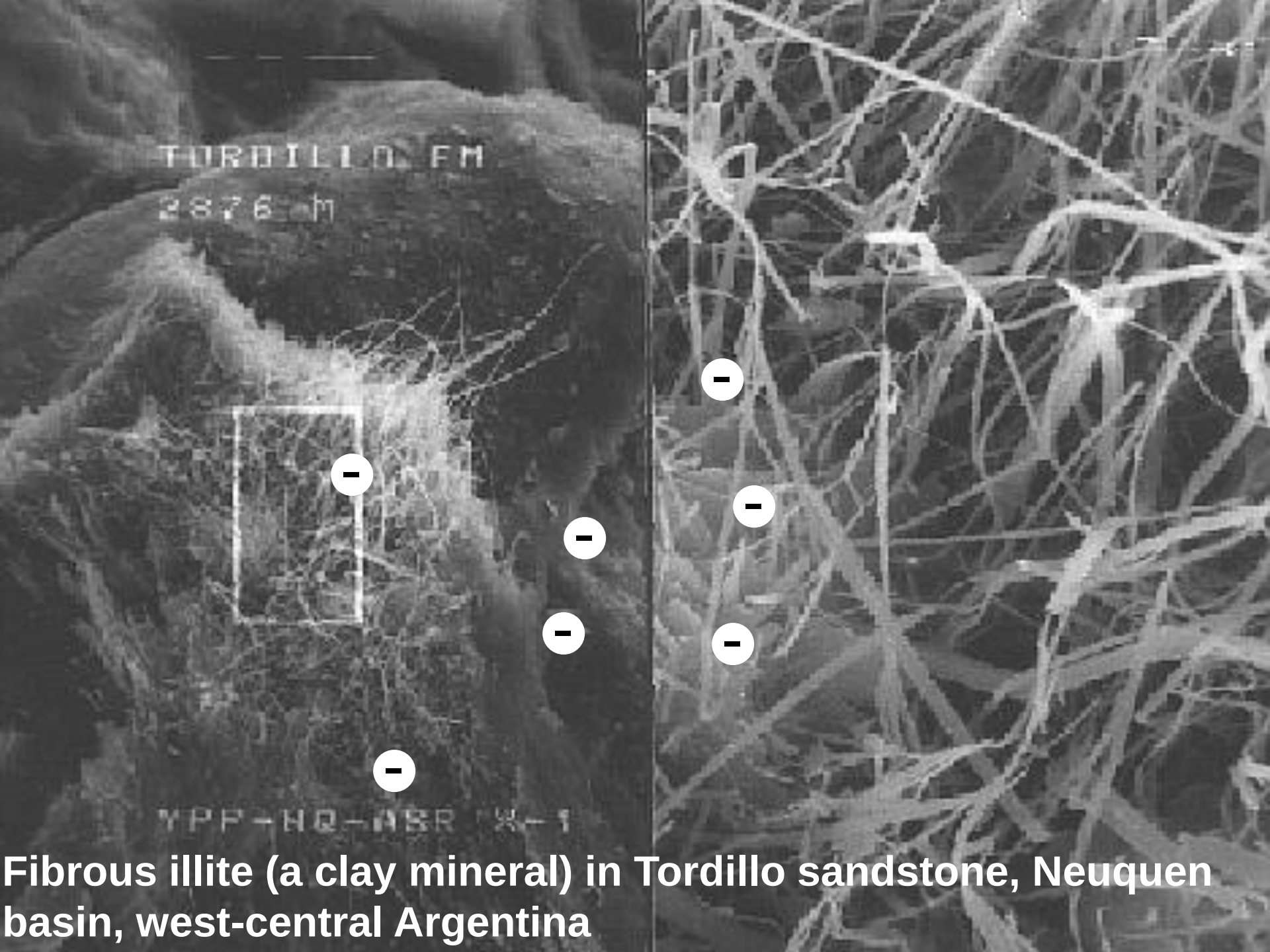
Silica Tetrahedral sheet

Aluminum Octahedral sheet

Silica Tetrahedral sheet


~ 100,000x magnification

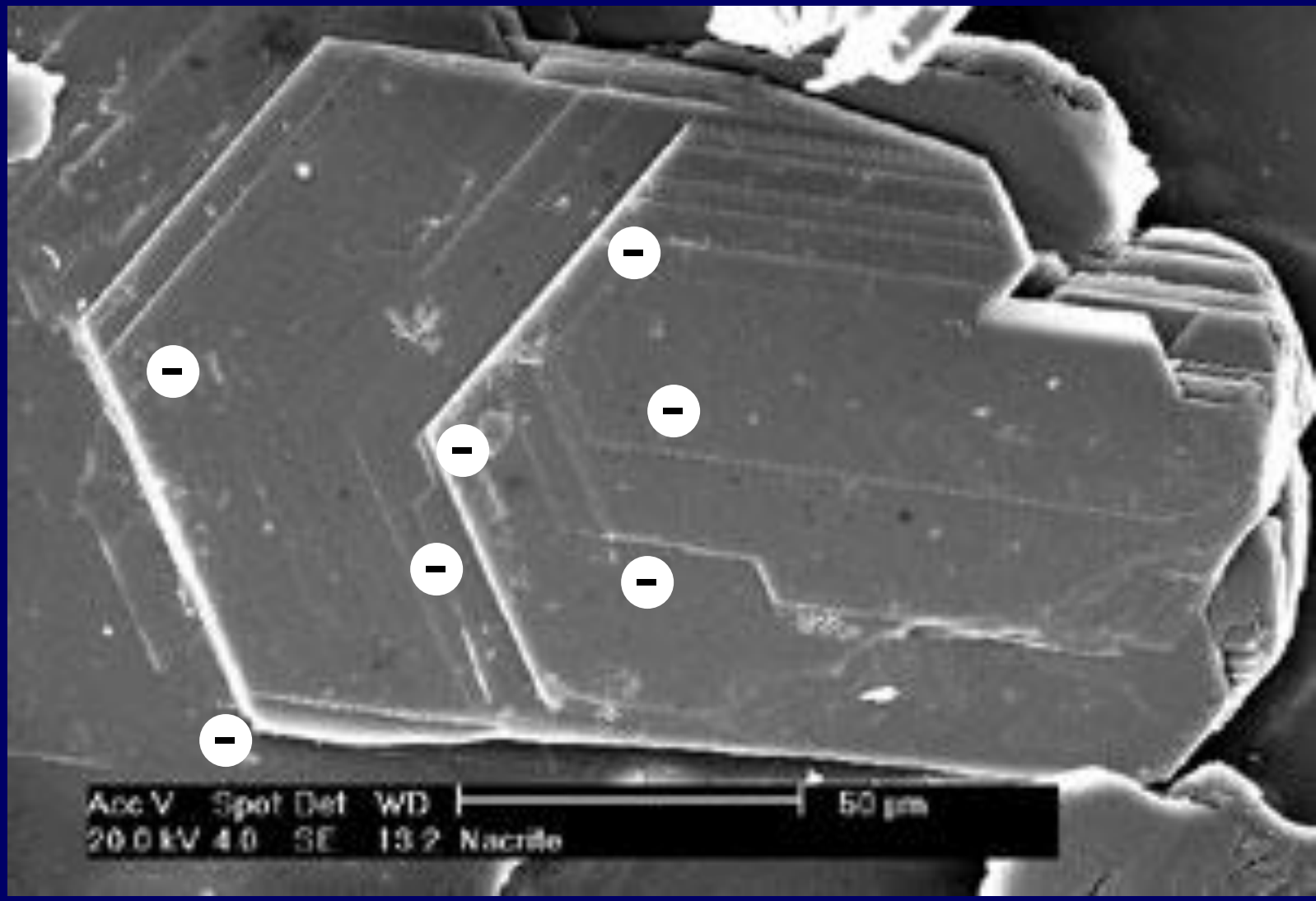

EPK (Edgar Plastic Kaolin) -25000x magnification
Courtesy of the SDSU Electron Microscope Facility



Fibrous illite (a clay mineral) in Tordillo sandstone, Neuquen basin, west-central Argentina

Nacrite, Lodève Basin, France

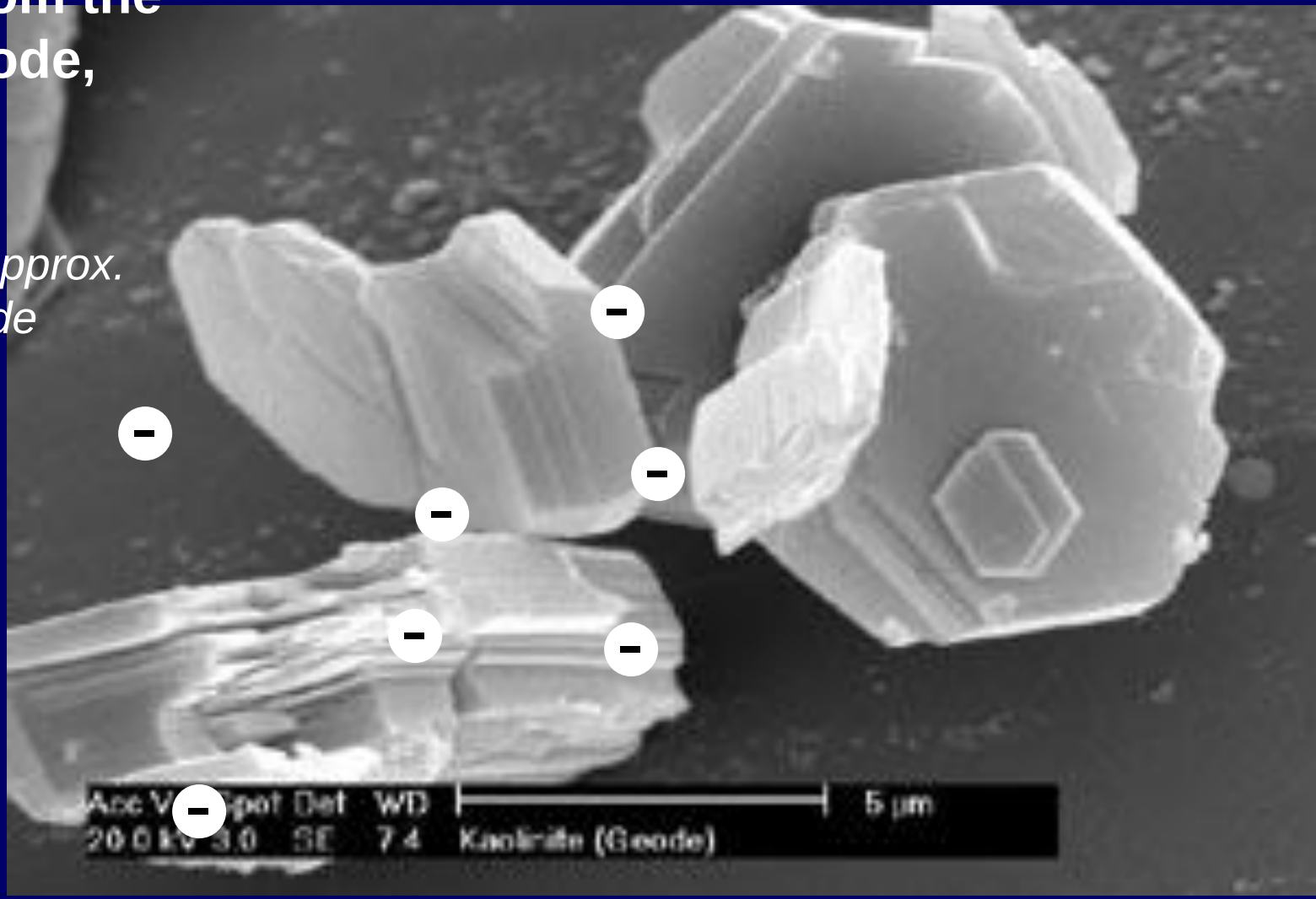
Field of view approx. 200 microns wide

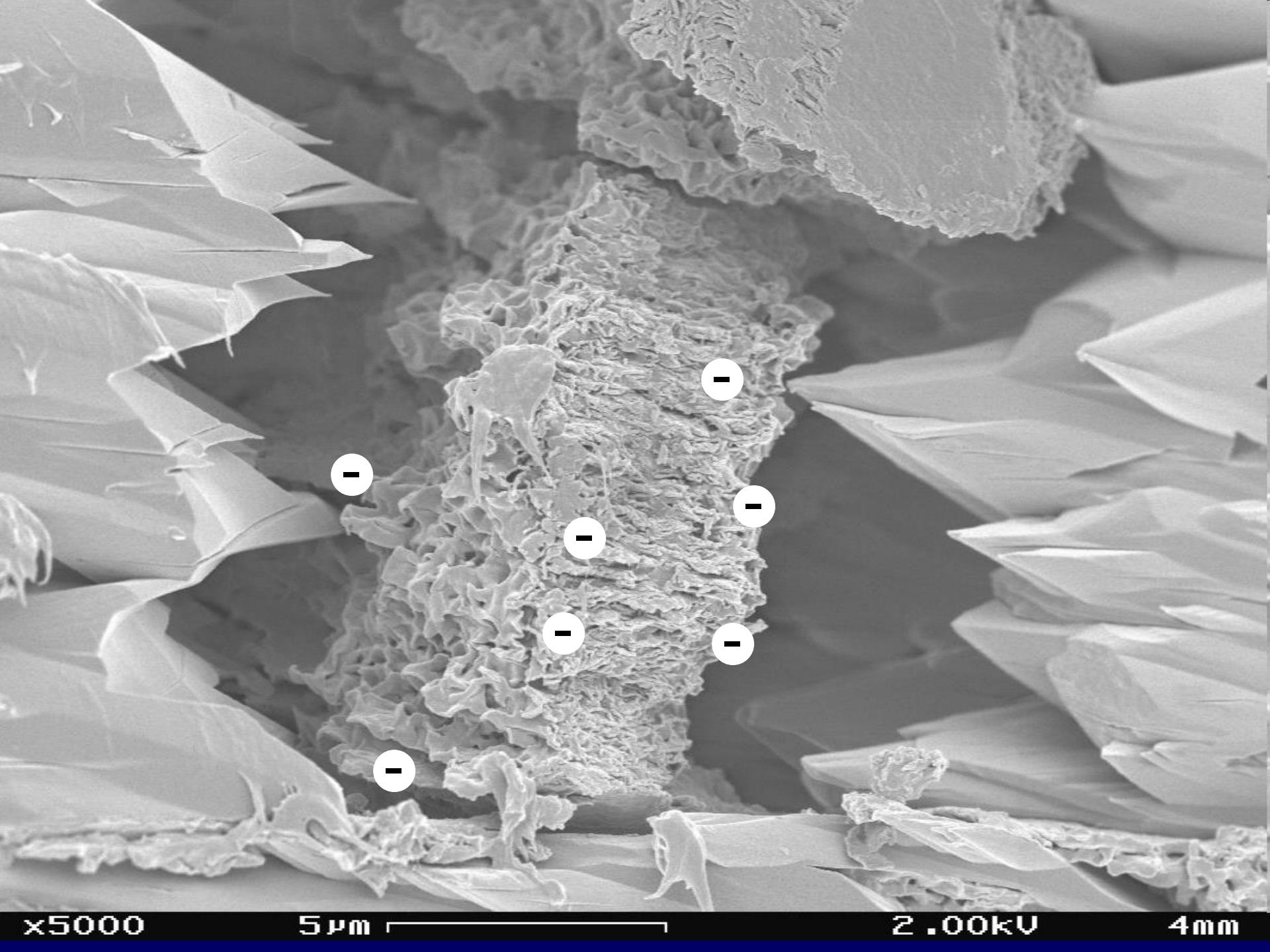


Kaolinite

Well crystallized kaolinite from the Keokuk geode, USA

Field of view approx. 18 microns wide




x5000
5µm
2.00kV
4mm

…net negative charge due to isomorphic substitution on the secondary mineral called clay!!!

Clay

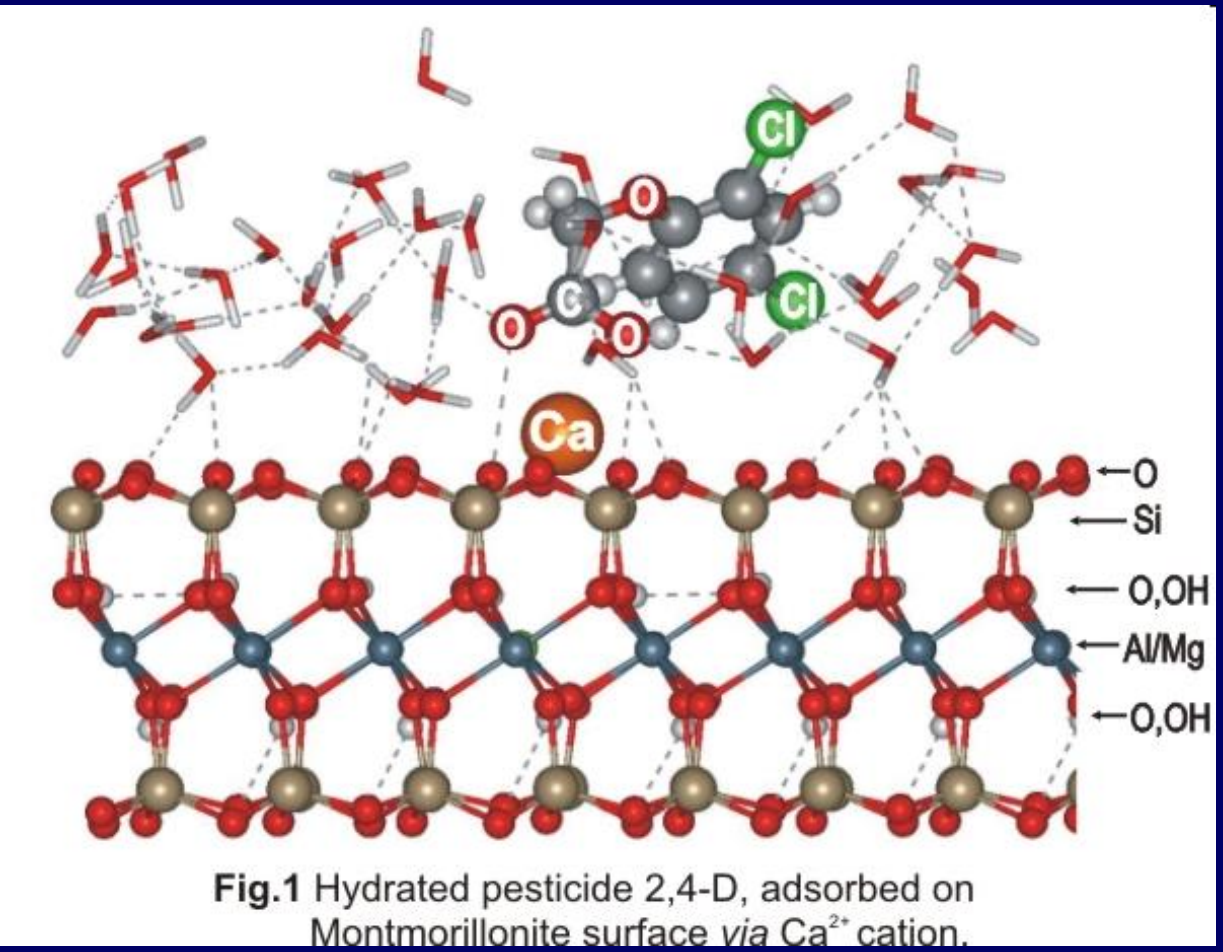
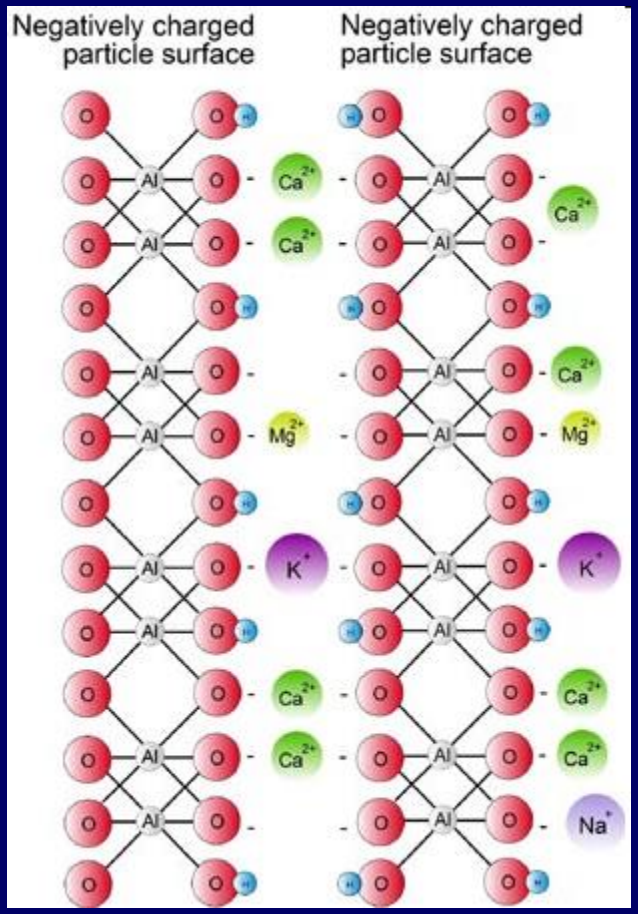


Fig.1 Hydrated pesticide 2,4-D, adsorbed on Montmorillonite surface *via* Ca^{2+} cation.



http://virtual-museum.soils.wisc.edu/soil_smectite/index.htm

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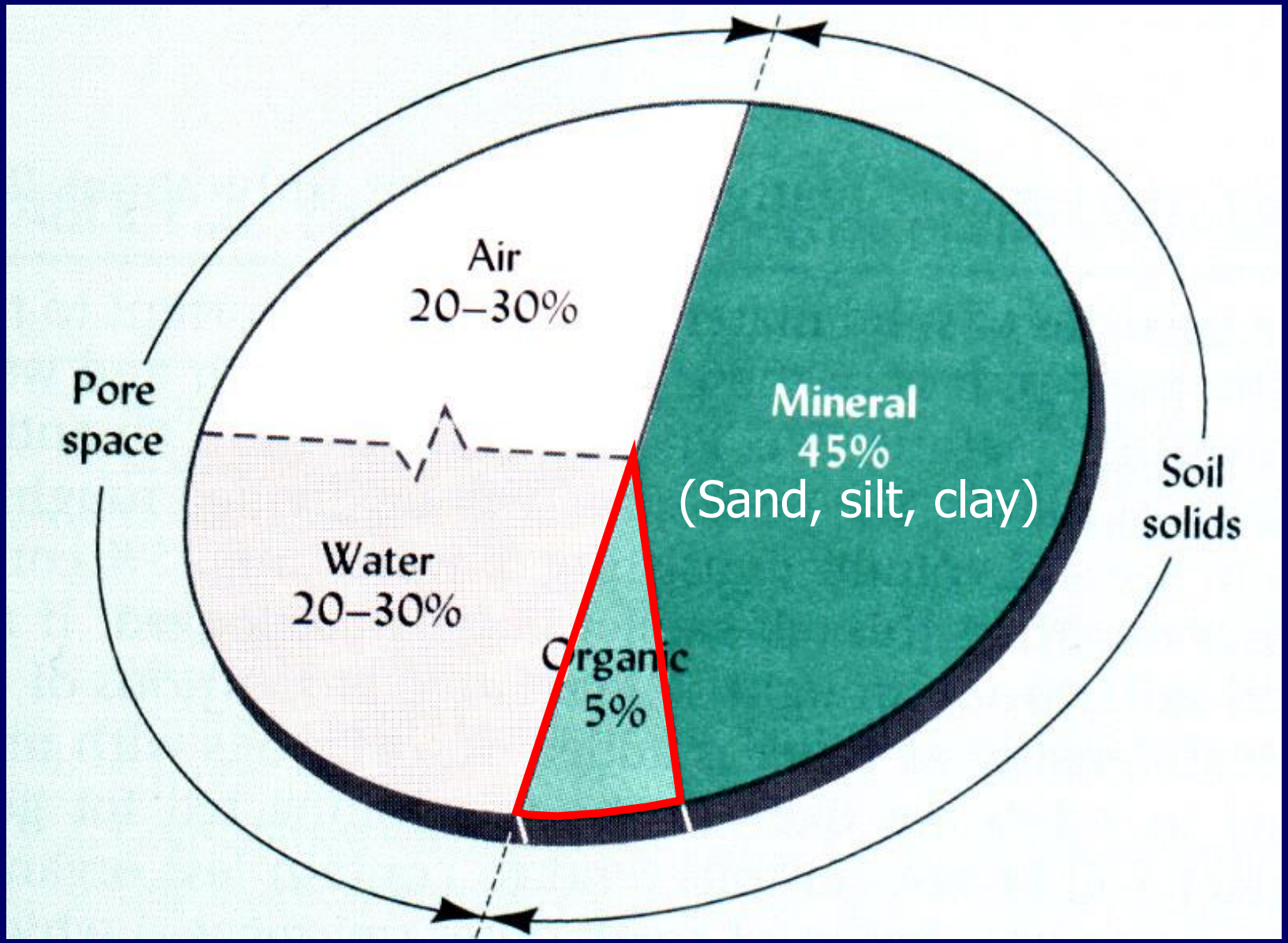
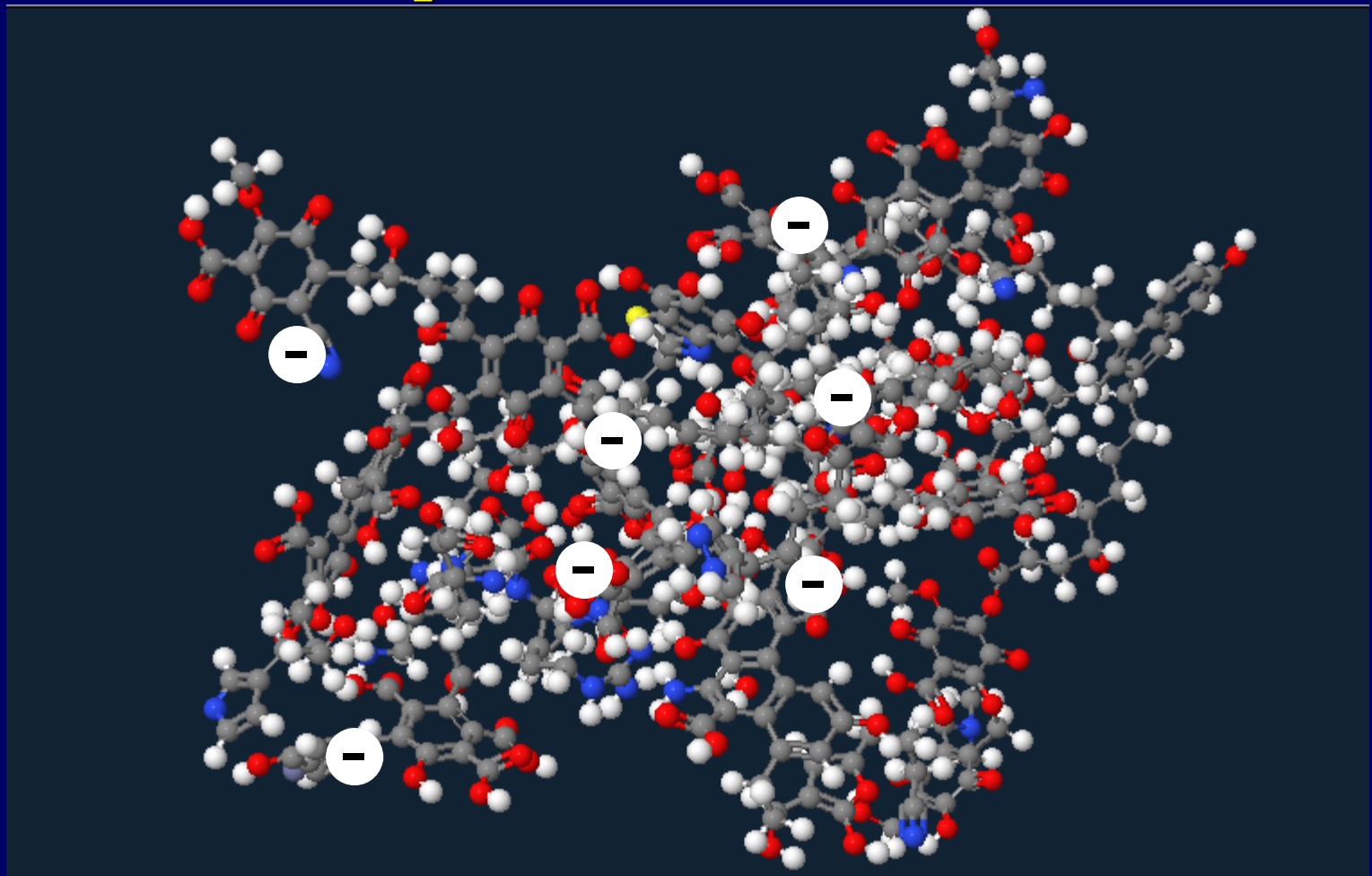
- **Decomposed Organic Matter**

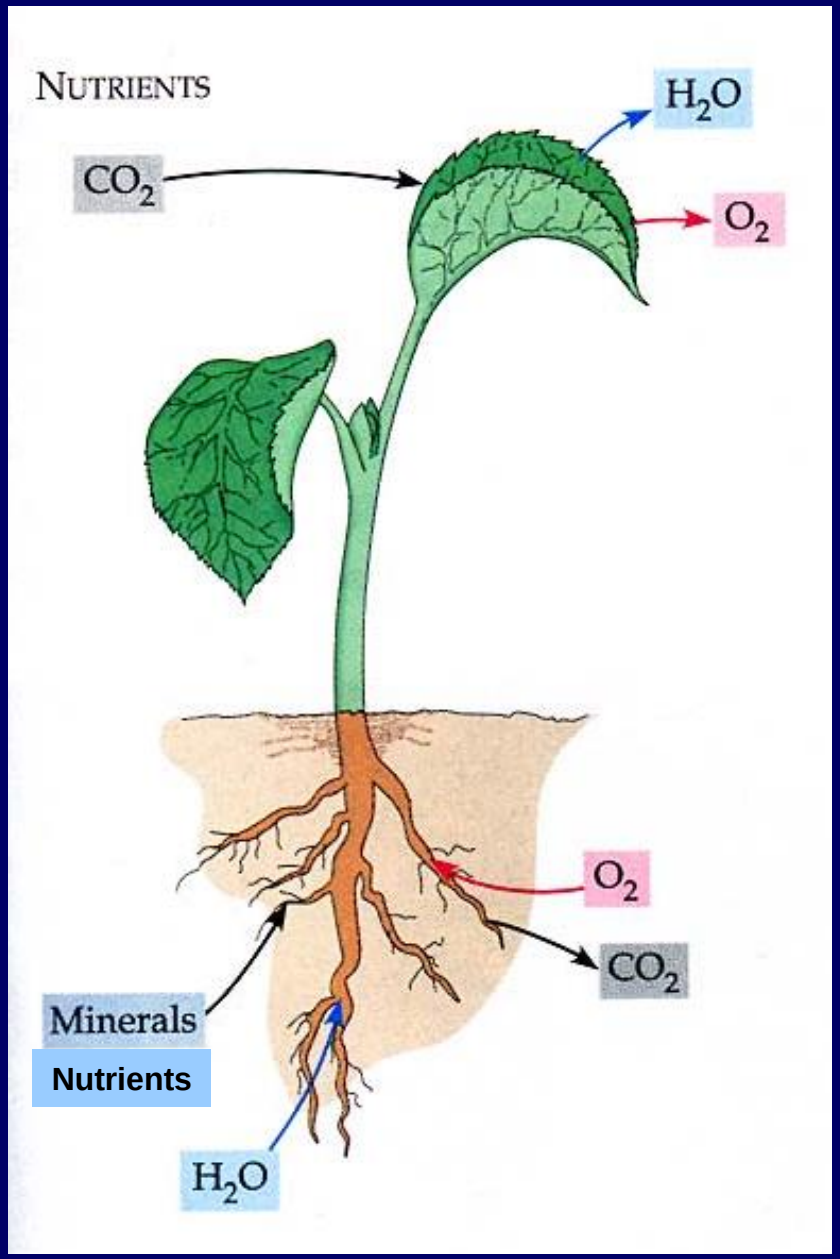
What is Organic Matter?



Organic Matter – a random complex molecule!



How a plant works



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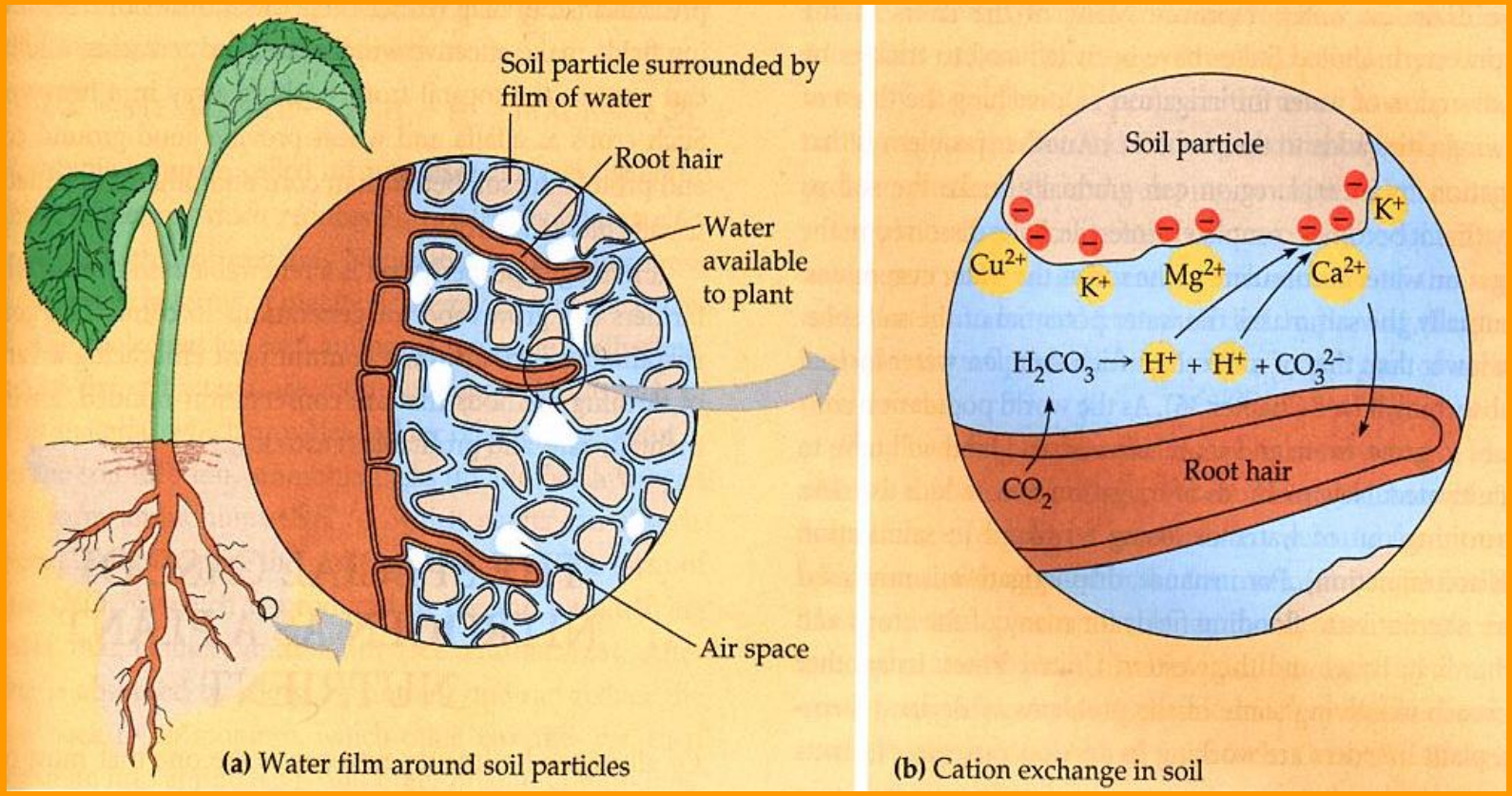


Soil the foundation of nutrition

2015 International Year of Soils

fao.org/soils-2015

Role of **18 nutrients** necessary for **plant growth** and **human health**

Promote plant growth

Improves winter hardiness

Involved in photosynthesis

Involved in carbohydrate metabolism and translocation of starches

Promote reproduction

Aid translocation of photosynthesis from leaves to fruiting organs

Acts as an O_2 carrier

Fruit formation

Quickens maturity

Fruit quality

Fruit flavour

Seed formation

Seed quality

Enhances maturity of small grains

Increases disease resistance

Reduces plant respiration

Promotes root formation and growth

Increases water-use efficiency

Stimulates microbial activity

Promote nodule formation on legumes

Aids in enzyme functionality and plant use of Fe and P

Responsible for enzyme activity

Helps enzyme activity and increases the availability of P and Ca

Plays a key role in brain and muscle function

Contributes to perception of taste

Needed for immune system health

Key component of protein

Essential for muscle and nerve activity

Important in immune system health, blood clotting and pressure regulation

A component of proteins, DNA, RNA and blood

Promotes digestive process

Maintains acid-base balance

Needed for proper fluid balance

Essential to fetal development and functioning of reproductive system

Key component of enzymes

Helps deliver oxygen to the tissues

Important for healthy bones

A component of enzymes, DNA, RNA, proteins and promotes immune system health

A component of enzymes and involved in Fe metabolism

Soil degradation leads to the **loss** of **soil micro** and **macronutrients**

Nutrient-poor soils are **unable** to **produce healthy food** with all the **necessary nutrients** for a **healthy person**

Over **2 billion people** suffer from micronutrient deficiencies

Sustainable soil management for **healthy soils**, **healthy food** and **healthy people**

Reduce erosion

Ensure crop rotation

Keep soil surface covered

Minimize tillage

Increase soil organic matter content

Soil macronutrients

Soil micronutrients

Food and Agriculture Organization of the United Nations

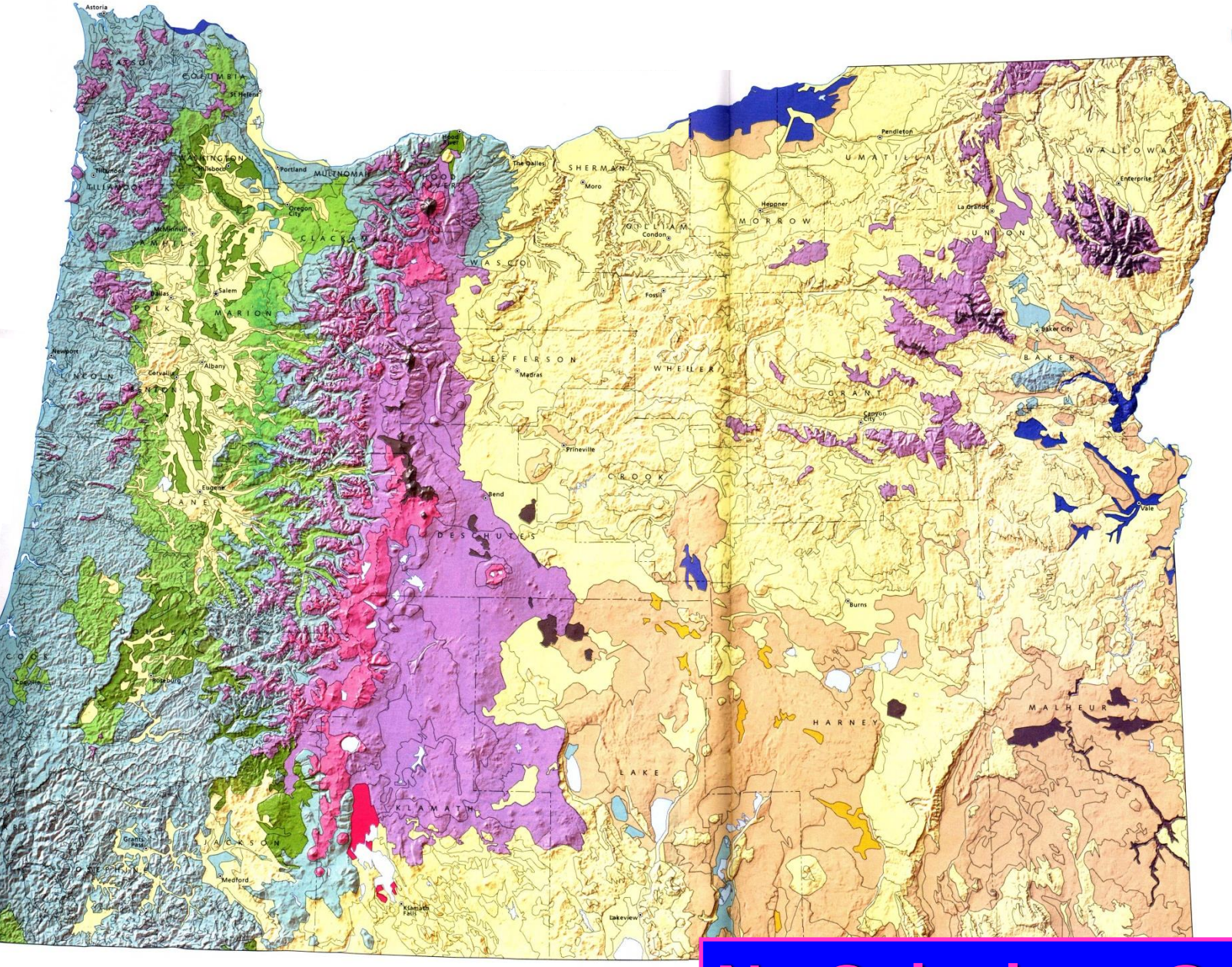
With the financial support of the Russian Federation

Healthy soils for a healthy life

soilforward.org

soilforward.org

Soil!



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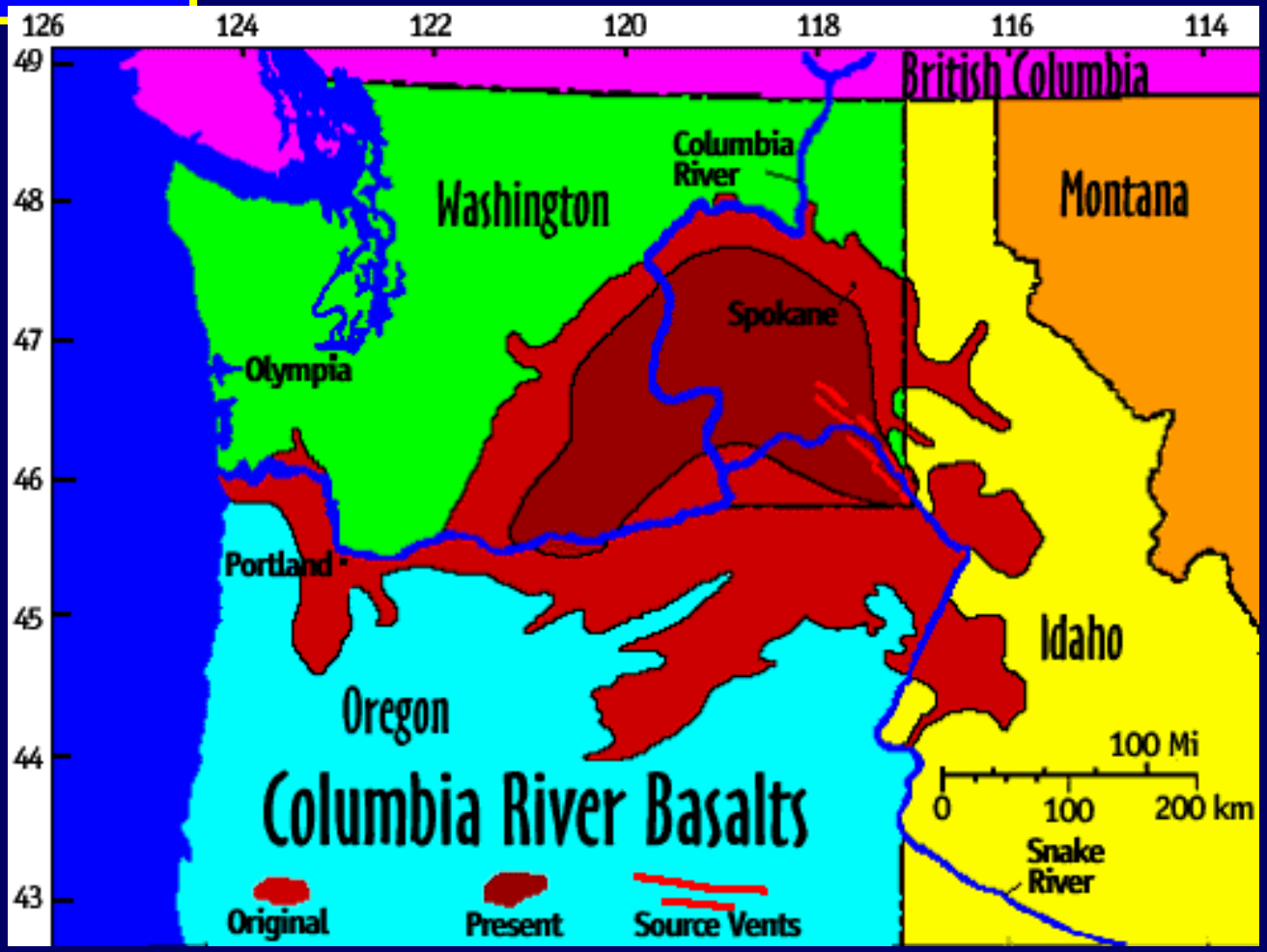
Formative events in Oregon Geologic History - #1

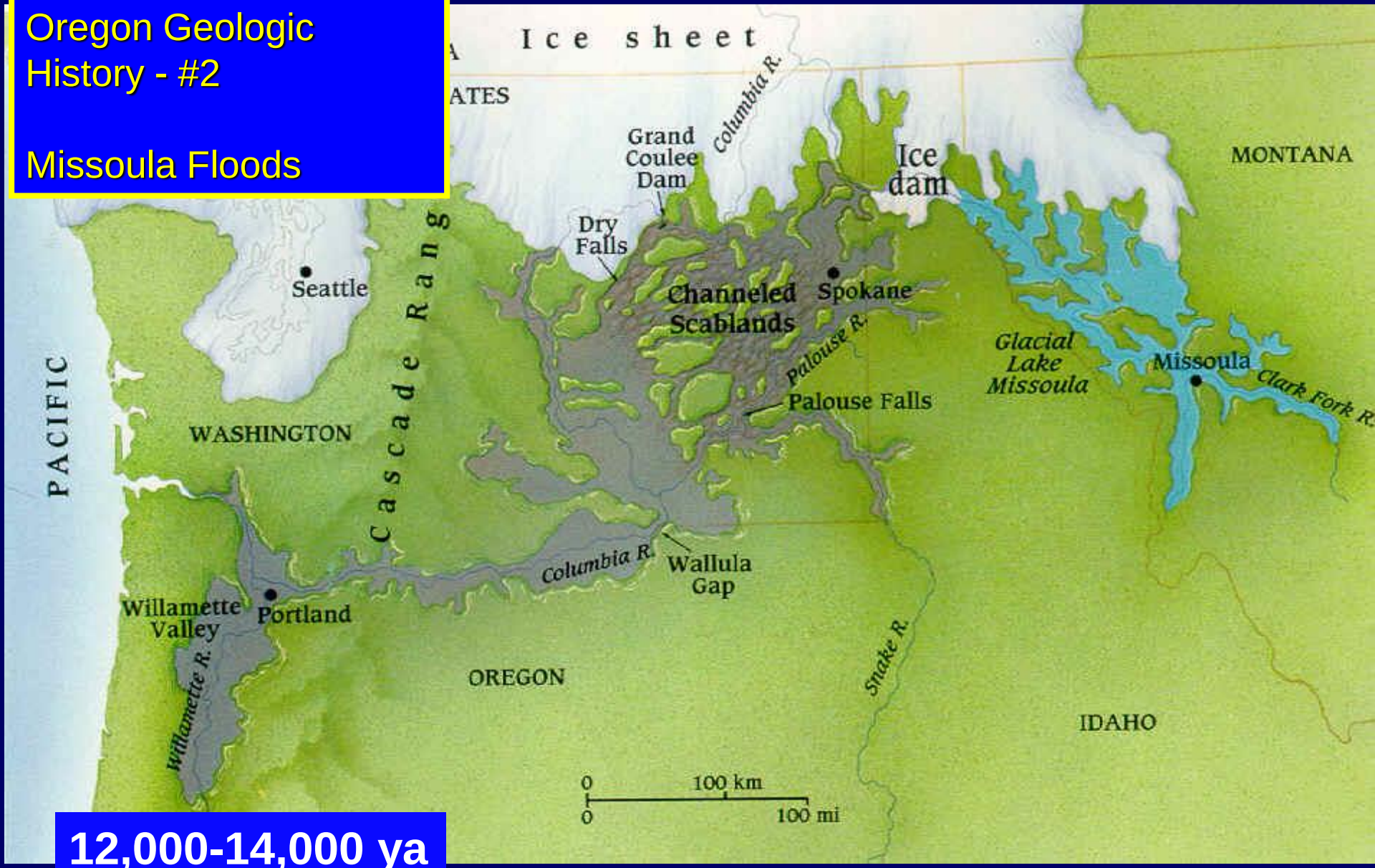
Columbia River Basalts



7-17 mya

Formative events in Oregon Geologic History - #2

Missoula Floods



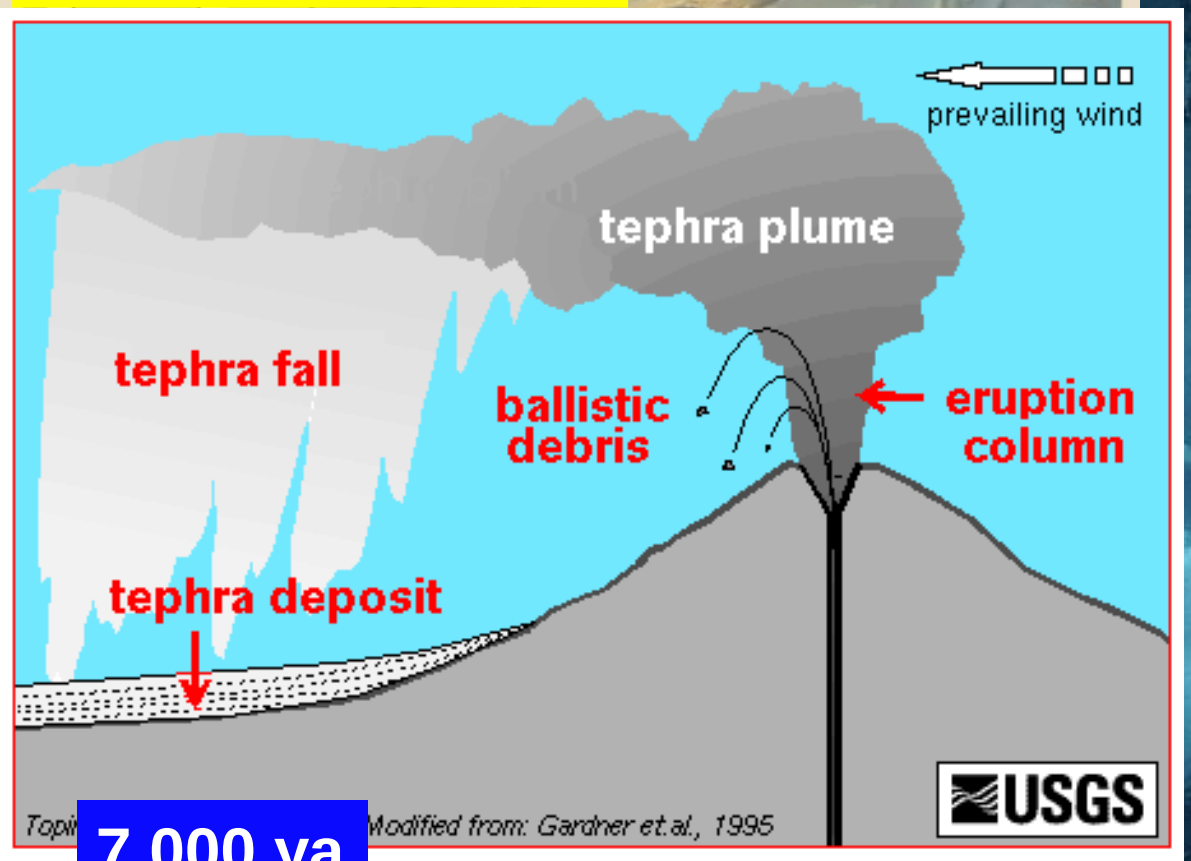
12,000-14,000 ya

http://www.pbs.org/wgbh/nova/megaflood/

Formative events in Oregon Geologic History - #3

Mount Mazama (Crater Lake)

- (Pre eruption) Mt. Mazama13,000ft high
- Climatic eruption - about 7000 years ago
- Mazama ash found in Nebraska

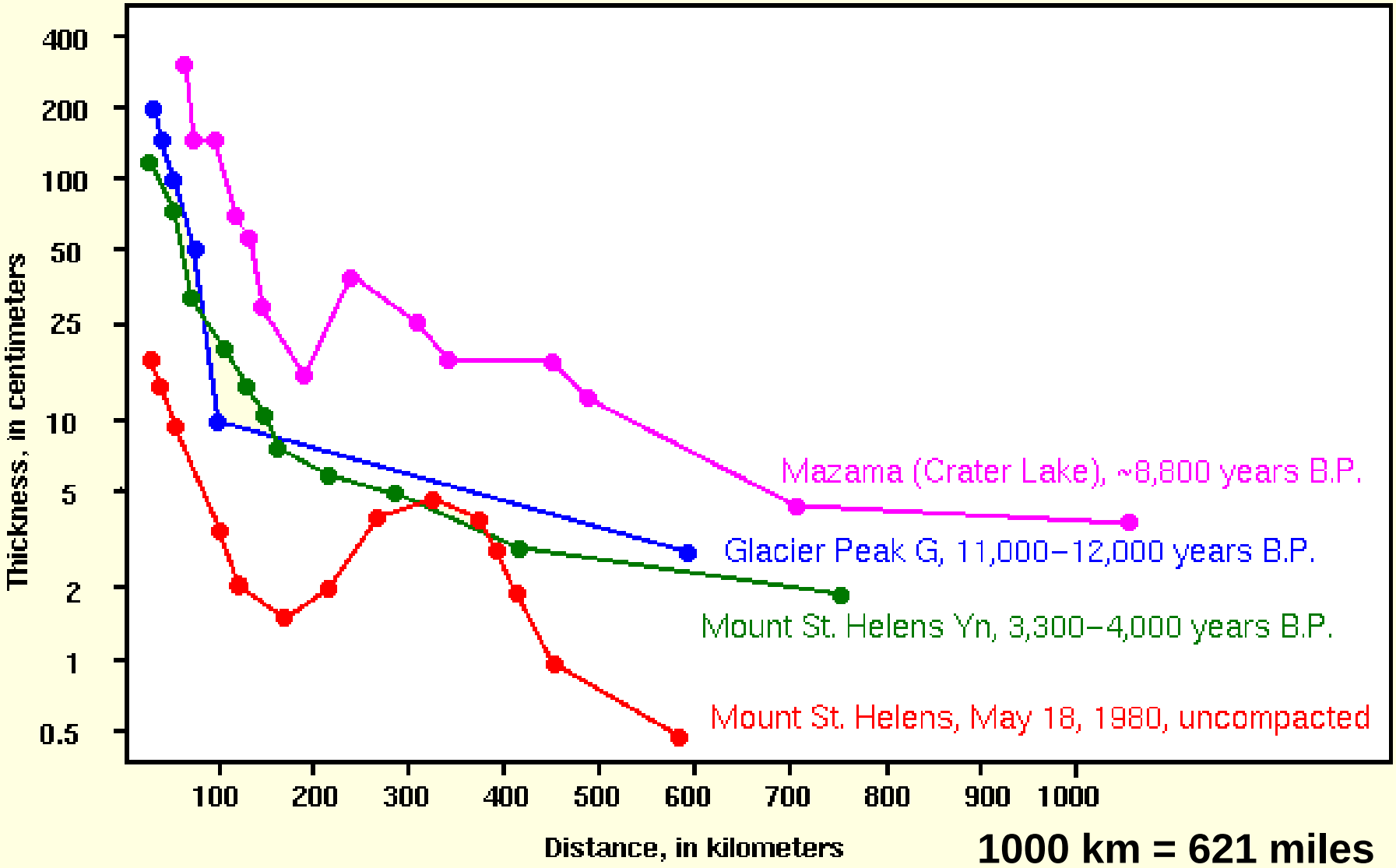


7,000 ya

Mount St. Hellens


USGS
USGS Photo by Lyn Topinka, August 22, 1980

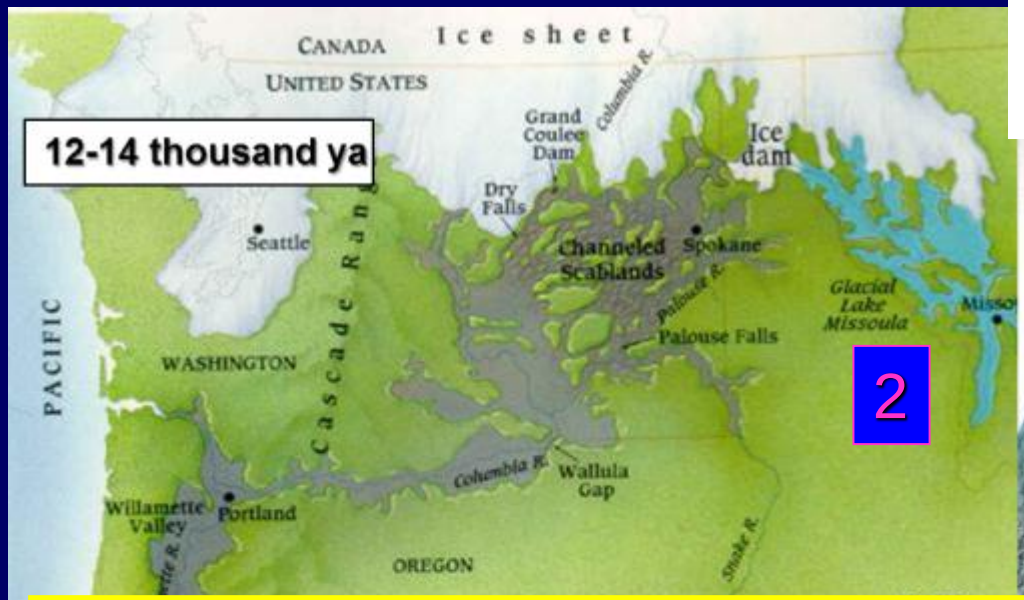
Thickness of Cascade Range Tephras vs. Distance from Vent

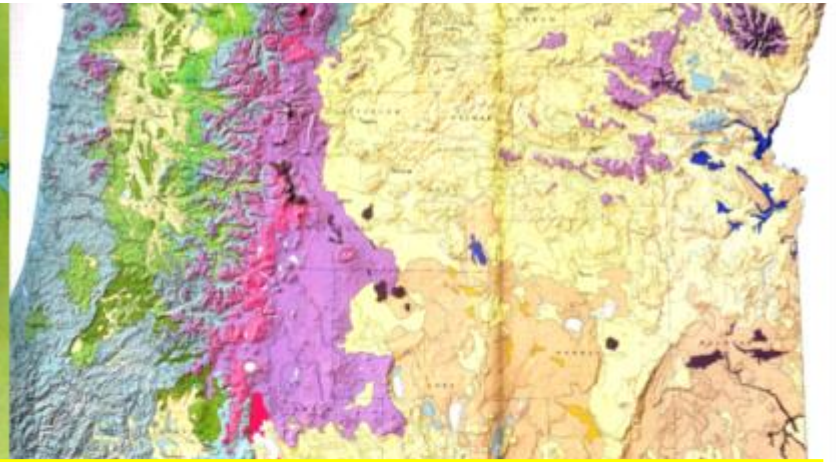


1000 km = 621 miles

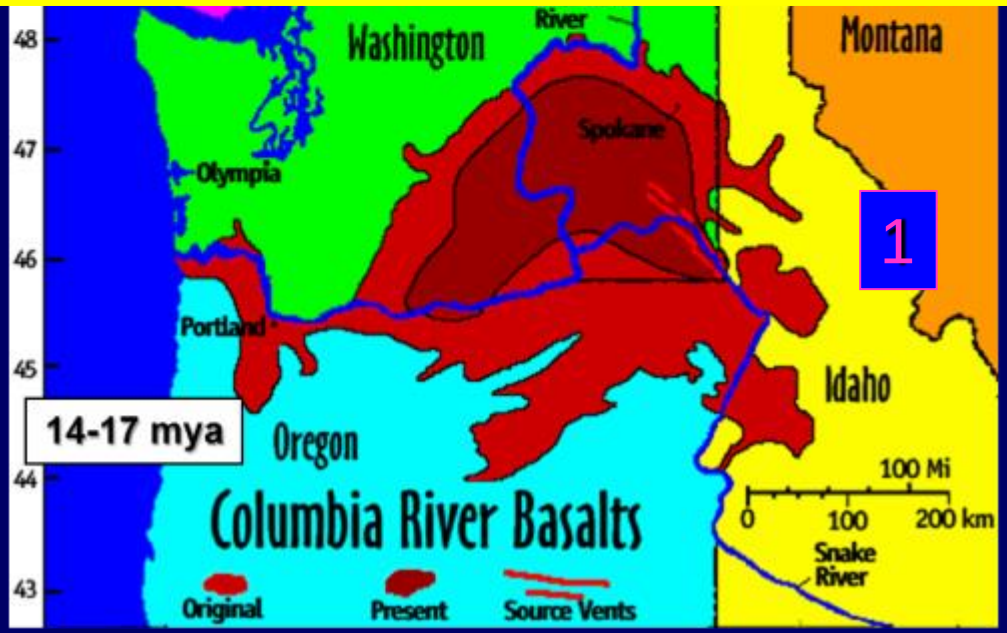

Salem
81 mi.
22
N
Willamette
National Forest
Pacific Crest
Scenic Trl.
Mt. Jefferson
Wilderness Area
Warm Springs
Indian Reservation
Lake Billy
Chinook
West Cascades
Scenic Byway
Three Fingered
Jack 7841'
McKenzie Pass -
Santiam Pass
Scenic Byway
Santiam Pass
4817'
126
20
Hoodoo
Ski Area
Suttle L.
Mt. Washington Overlook
Black Butte
6436'
Sahalie Falls
Waterfalls
Loop
Koosah
Falls
Clear L.
Mt. Washington
Wilderness Area
Mt. Washington
7794'
20
Belknap Crater
6872'
Windy Point
East Portal
Sisters
126
Belknap
Viewpoint
Dee Wright Observatory
McKenzie Pass
5325'
Smith R.
126
West
Portal
20
242
McKenzie
Ranger Station
Proxy Falls
North Sister
10085'
Middle Sister
10047'
Deschutes
National
Forest
Deschutes R.
Three Sisters
Wilderness Area
South Sister
10358'
Broken Top
9175'
Bend

3 major formative events in Oregon's geologic history





But so much more…Accreted and up lifted marine sediments and corals, volcanic island arcs and submarine lava flows…



A & L WESTERN AGRICULTURAL LABORATORIES

1311 WOODLAND AVE #1 • MODESTO, CALIFORNIA 95351 • (209) 529-4080 • FAX (209) 529-4736

REPORT NUMBER: 00-336-046 CLIENT NO: 99999

SEND TO: EXAMPLE REPORT
1311 WOODLAND AVE.
MODESTO, CA 95351-

GROWER: EXAMPLE REPORT

SUBMITTED BY:

Graphical Soil Analysis Report

DATE OF REPORT: 07/10/04 LAB NO: 55930 SAMPLE ID: VEG PAGE: 1

Analyte	Organic Matter %	Nitrogen NO_3-N ppm	Phosphorus Weak Bray ppm	Phosphorus $NaHCO_3$-P ppm	Potassium K ppm	Magnesium Mg ppm	Calcium Ca ppm	Sodium Na ppm	Sulfur SO_4-S ppm	Zinc Zn ppm	Manganese Mn ppm	Iron Fe ppm	Copper Cu ppm	Boron B ppm	
Results	2.7	5	3	4	209	648	1231	16	1	0.7	87	31	1.1	0.4	
		LOW	AVERAGE		HIGH										

Percent Cation Saturation (computed)

Potassium K %	Magnesium Mg %	Calcium Ca %	Sodium Na %
3.5	34.9	40.2	0.5
ACIDIC		BASIC	

0.1		15.3	L	5.7	
ECe dS/m	INCREASING SALINITY →	CEC meq/100g	Ex. Lime	pH	← INCREASING NEED FOR LIME

Buffer pH: 6.6

NaHCO3-P unreliable at this soil pH

Soil Fertility Guidelines

CROP: ORGANIC VEG RATE: lb/acre NOTES:

Dolomite (70 score)	Lime (70 score)	Gypsum	Elemental Sulfur	Nitrogen N	Phosphate P_2O_5	Potash K_2O	Magnesium Mg	Sulfur SO_4-S	Zinc Zn	Manganese Mn	Iron Fe	Copper Cu	Boron B	
	4000			110	300	120		30	10				0.5	

COMMENTS

NITROGEN sources include composts and legumes as well as blood meal, cottonseed meal, hoof & horn meal, fish meal, or chicken feather meal. Sodium nitrate is not recommended. Monitor brix levels.
PHOSPHATE: Availability varies with product. However, poultry-based composts are a good source. Otherwise, consider bone meal or soft rock phosphate. Blood & bone meal will also provide nitrogen.
POTASH: Composts may be a significant source of potash. Certain sources of sulfate of potash may also be used, as well as kelp/seaweed products, wood ash, crushed granite and greensand.
MICRONUTRIENTS: Kelp/seaweed, greensand, rockdust, wood ash, or even certain synthetics may be used if essential. Avoid over-application! Liquid foliar feeding may work best.

Mike Buttress, CPAg

Oregon State University
Central Analytical Laboratory

Crop and Soil Science Department 3079 Ag-Life Sciences Bldg Corvallis, OR 97331 541-737-2187

Soil Nutrient Analysis Results

Name:	James Cassidy
Organization:	OSU CSS
Contact for results:	james.cassidy@oregonstate.edu
Date submitted:	9/27/2016
Date delivered:	10/14/2016
Group number:	Gp217087

Nitrate and ammonia were extracted using 2M KCl.
Other nutrients were extracted using the Mehlich-3 procedure.
pH and EC were measured in a 2:1 water:soil slurry.
Units are given as reported in recommendations in OSU extension publications.

	ppm							meq/100g			%		
Sample ID	P	K	Mn	Cu	Zn	Fe	NO3-N	Ca	Mg	CEC	C	N	C/N ratio
1	64	152	13.2	1.4	3.7	268	BDL	5.0	1.8	7.2	5.3	0.3	16.7

BDL = Below detection limit

	pH units		µS/cm
Sample ID	pH	BpH	EC
1	5.5	6.0	76.6